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THE SIXTY-THIRD ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

Issued in Accordance with Section 8, Chapter 75, of the General Laws

PART I.—THE REPORT OF THE PRESIDENT AND OTHER OFFICERS OF ADMINISTRATION FOR THE FISCAL YEAR ENDED NOV. 30, 1925

DEPARTMENT OF EDUCATION
THE COMMONWEALTH OF MASSACHUSETTS

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EDWARD M. LEWIS, *Acting President of Massachusetts Agricultural College.*

MASSACHUSETTS AGRICULTURAL COLLEGE.

PRESIDENT'S REPORT, 1925.

REVIEW OF THE YEAR.

In Memoriam.

Hon. Charles A. Gleason.

On September 29, 1925 our long time friend and co-worker, Mr. Charles A. Gleason, died suddenly at his home in North Brookfield. The news came as a great shock to all of us, I am sure, as well as to the great number of his fellow citizens who had learned to know the great qualities of his character both as a man and as a public servant. We shall all miss him. The loss of his superlative guidance and wisdom as the leader of the Board of Trustees will be felt for many years to come. The length and the quality of service rendered by him to the State and to the College are memorable and inspiring. They demand the grateful recognition of every citizen of Massachusetts.

Mr. Gleason was born on a farm at New Braintree, February 7, 1846. Here he continued to live for nearly half a century. He made it a model of progressive and profitable farming. He taught school when a young man, with the same progressiveness and thoroughness. His town very early recognized his great qualities of mind and heart, his energy, his wisdom, his uprightness, and elected him tax-collector when he was only twenty-one; he held the office fourteen years. For eighteen years or more he served on the school board; he was also town treasurer, assessor, selectman, and, as long as he lived in New Braintree, moderator of the town meetings. In 1873 he began his service in the State House of Representatives and was a member of the Committee on Banks and Banking. For three years he served in the Senate, and was a member of the committees on Banks and Banking, Education, Liquor Laws, Agriculture, and Public Health. For seven years Mr. Gleason was President of the New England Milk Producers' Association. His business interests caused him in the nineties to take up his residence in Worcester and later in Springfield where he remained for about twenty years. He returned to spend the last five years of his life in North Brookfield. Throughout his life he found time to be most active in the work of his church.

To the friends and alumni of the Massachusetts Agricultural College, however, it will be Mr. Gleason's remarkable service to the institution that will always stand out and remain as one of its most treasured heritages. He served as a trustee of the College for thirty-six years. As Chairman of the Finance Committee, Auditor of the College, and Vice-President of the Board of Trustees, he gave an amount and quality of service that will never be excelled. In every office he revealed himself as the conscientious, practical, tireless official, the just and generous man. His lifelong experience on the farm and in business and public affairs, made him ideally fitted to serve as trustee. His constant endeavor to support the great cause of agriculture and know the problem of education as it is today, to keep up with it, and to ascertain the solutions offered for it, were among the most noticeable characteristics of the man. He was in truth a loyal friend of the College and an exemplary citizen of the Commonwealth.

The Death of James C. Greenough.

James Carruthers Greenough, seventh president of the Massachusetts Agricultural College died at his home in Westfield, December 4, 1924. He was born at Wendell, August 15, 1829, and was a graduate of Williams College. He was

Principal of Rhode Island State Normal School for twelve years, 1871-1883, and became the President of the College, on the death of President Chadbourne. He resigned, however, in 1886, after only three years' service, and returned to his old duties as a normal school principal. He served for some years in this capacity in Westfield, but increasing physical infirmities finally made it impossible for him to continue active life though he lived on to the grand old age of ninety-five.

During his administration several new buildings were erected; great accessions were made to the library; the course of study was expanded and the Faculty greatly strengthened. Though his was a brief administration it was notable for its contribution to learning and scholarship.

New Appointments.

At the beginning of the college year in September, Wallace F. Powers joined the staff as Professor and Head of the Department of Physics, succeeding the late Philip B. Hasbrouck. Dr. Powers graduated from Clark College in 1910, and received his doctorate from the same institution in 1914. He comes to us highly recommended after four years of successful teaching in Wesleyan University as Assistant Professor of Physics.

Cavalry Barn.

Early in the evening of September 3rd the Cavalry Barn was destroyed by fire. An investigation by local and state authorities resulted in no definite conclusion as to the cause of the fire. The premises were under constant guard of a soldier of the regular army and the fire originated while the stable was thus guarded. The horses were fortunately removed from the stable and much of the movable equipment. All of the forage, however, and considerable cavalry equipment were destroyed. The estimated value of the forage was $1,583 and of other army stores $4,698. The building was the property of the State; the forage and equipment were owned by the Federal Government.

Application was immediately made to the Governor for an appropriation from the emergency fund to replace the stable; on October 14th an appropriation of $16,500 was granted. The stable facilities are being reconstructed in three fire-proof units, consisting of the main stable for the shelter of animals, a separate building for the storage of forage, and a third building to be used as a blacksmith shop. The stable will probably be ready for occupancy early in January.

New Construction.

Practically no new construction was provided by legislative appropriation of 1925. Under such appropriations as were made $1,000 has been expended for the extension along the easterly side of Olmsted Road of the concrete walk begun in 1924; $3,000 was expended in fencing the fruit plantations and $4,000 was expended in the replacement of livestock.

Commencement 1925.

At the annual commencement in June diplomas were awarded to 74 men and 4 women. The degree of Master of Science was conferred on 2 men and 1 woman.

The commencement address was delivered by Dr. Edwin W. Allen, of the United States Department of Agriculture, a graduate of the College in the Class of 1885. For the first time in fifteen years the College was honored by the presence of the Governor of the Commonwealth, Hon. Alvan T. Fuller, who delivered a timely and appropriate address.

Enrollment.

The enrollment of four-year students this autumn is 516, representing an increase of approximately 5% over the enrollment of 490 in the autumn of 1924. The number entering the Freshman class is this year 179 as compared with 184 of a year ago. The number of men in the Freshmen class shows a decrease of 13 and the number of women increased by 8. An analysis of the number of women entering each Freshman class of the past 8 years together with the corresponding percentage of the total enrollment is as follows:

	No.	Per Cent.
1918	4	3.4
1919	9	7.2
1920	11	8.1
1921	15	9.3
1922	20	10.7
1923	13	10.4
1924	31	16.8
1925	39	21.8

In the two-year course, 105 were admitted this year as compared with 94 admitted in 1924. The total enrollment of the two-year course is 192, an increase of 20% over the enrollment of 1924.

Tuition.

During the legislative session of 1925 the question was raised as to the desirability of establishing a tuition charge for residents of Massachusetts enrolled at the Massachusetts Agricultural College. During the past months this problem has been still further urged upon us by responsible members of the Legislature and during the session of 1926 consideration of this problem is quite likely to take more definite form than previously.

In view of this possibility the following facts should be before you. When the College first opened in 1867, a tuition charge of $36 per year was established. In 1870 this tuition was increased to $54 per year. In 1873 it was increased to $75 per year. From 1879 to 1883 the tuition was reduced to $36 per year and in 1884 a tuition charge of $80 was established by the Trustees. This was continued till 1899. While, for over thirty years the catalogue announced a tuition charge for residents of the State, nevertheless, free scholarships were granted from the outset and a fair proportion of the needy students were able to attend the institution without the payment of tuition. Free scholarships were also offered by the Massachusetts Society for the Promotion of Agriculture and by the various agricultural societies of the State. In 1878 the Trustees by vote established one free scholarship for each of the eleven congressional districts of the State. In 1883 the Legislature increased the opportunity for free tuition by appropriating money to the College to cover eighty free scholarships. These scholarships, together with those already established, by the Trustees, provided free tuition to practically every student.

From 1884 to 1898 inclusive the catalogue of the College included the following announcement:

"Students whose homes are within the State of Massachusetts can in most cases obtain a scholarship by applying to the Senator of the districts in which they live."

In the catalogue for 1902 and for several subsequent years, there appears the following statement:

"Tuition is free to citizens of the United States. Citizens of Massachusetts, however, in accordance with an act of the Legislature, must make application to the Senator of the district in which they live for a free scholarship that covers the charge for tuition. Blank forms for such application may be obtained from the president of the college."

In 1905 the Legislature increased the number of free scholarships from 80 to 120 and made a specific appropriation to provide these free scholarships.

Thus it appears that while tuition has been charged it has been the intent of the Legislature that tuition should be fairly free at the Massachusetts Agricultural College.

An analysis of the practice of other State Agricultural Colleges reveals the fact that at the present time 32 charge no direct tuition to residents of the State. Of the 11 which do charge a specific tuition fee, at least three construe the tuition fee to be a general incidental fee. In three additional states there is an arrangement whereby indigent students may be relieved from paying the tuition fee as advertised. On the other hand it should be said that a tuition charge is now being considered at other state institutions here and there. Some of our neighbors have adopted the policy of such a charge. The University of Vermont, a semi-private institution, charges $200; New Hampshire $75, plus $54.50 for incidentals; Maine, $125 and New Jersey $200. Each of these, however, provides a free scholarship arrangement for needy students. The practice of the majority of other institutions, however, furnishes no argument for Massachusetts to impose a tuition fee on the ground that such a charge is generally made elsewhere. However, it is conceded that the Legislature may fairly raise at any time the question of the extent to which this state shall bear the cost of higher education.

Presumably this issue is now raised because of the possibility which it affords for increasing the revenue of the state; the question of whether tuition is to be charged, should find its answer in part in the consideration of the amount of revenue which is to be obtained thereby. I am of the opinion that probably a moderate fee will impose no undue hardship upon many of the students entering the college; but if this is to be done I believe that at the same time there should be a liberal system of scholarships established to meet the needs of that group of students who are likely to continue to apply for admission, and for whom there is no opportunity for a college education of our type, except at an institution where tuition is free. The alternative is a flat charge upon every student placed so low that it will not prove a serious hardship to the worthy student who needs and desires our kind of training.

Scope of the College.

A question of first importance facing the Board is the one connected with the scope of the College. You will remember that President Butterfield raised this question squarely in his last report by recommending expansion along three definite lines. On account of his departure and the urgent necessity of dealing with the problem of State House relationship the consideration of this important question has been delayed. The time has now arrived when a start should be made towards a decision. Necessarily a final and satisfactory one must be based upon careful study and discussion, and though I hope it may be taken up without hurry it ought to be pressed to a decision without undue delay. I therefore recommend that a committee be appointed at once to study and consider this fundamental and far-reaching question.

Infirmary.

The activities of the College Infirmary center in the care of students who suffer from illness and require attention. A recital of what the Infirmary has done during the period from September 1, 1924 to September 1, 1925 will be of interest.

There have been eighty-five house-patients treated for various lengths of time, amounting in all to four hundred and thirty hospital days. Besides, three hundred and fifty out-patients, making a total of five hundred visits, received first-aid assistance and other minor treatment.

The important diseases were:

Appendicitis	6 cases
Bronchitis	2 cases
Colds	4 cases
Exhaustion	2 cases
German measles	1 case
Heart disease	2 cases
Indigestion	3 cases
Infections	9 cases
Influenza	20 cases
Mumps	1 case
Pink eye	1 case
Poison ivy poisoning	1 case
Scarlet fever	1 case
Tonsillitis	15 cases
Miscellaneous (mainly of a minor or surgical nature)	18 cases

The communicable diseases are always of especial interest in an institution of this kind. Students, free to come and go, may contract communicable disorders readily. Our institution may consider itself fortunate during the past year in this respect as will be indicated in the list just cited.

The students as a whole are vigorous and sound and not easily subject to ailments. Out-door physical exercise, physical education, and military instruction contribute to this condition.

Much credit is due our resident nurse, Miss Christopher, and our matron, Mrs. McCrae.

Market-Garden Field Station.

On January 27, 1925 the personal force of the Market Garden Field Station moved from the farmhouse, (temporary headquarters) to the newly completed administration building at 240 Beaver Street. (Removal from North Lexington to Warren Estate, Waltham, September 15, 1924). The staff then consisted of Ray M. Koon, Extension Specialist in Vegetable Gardening, in charge; Paul W. Dempsey, Field Superintendent; W. L. Doran, Assistant Research Professor of Botany; V. A. Tiedjens, Assistant Research Professor in Vegetable Gardening; and Edith E. Meehan, Office Manager. On April 15, W. L. Doran was transferred to Amherst and was succeeded by Dr. E. F. Guba on April 24.

On September 1, Professor W. D. Whitcomb, who joined the staff July 1st on a half-time basis, assumed his duties as full time Field Station Entomologist. He has been engaged in developing a more effective control for Red Spider. The results are encouraging.

Dr. Guba has made a notable advance in vegetable disease control, particularly by means of the vaporization of sulfur in greenhouses. He has rendered a report on the application of Holland's Bordeaux and prepared two papers and ten news articles for publication. In addition he has made 250 personal extension contacts.

Professor Tiedjens has progressed steadily with his study of the vegetative propagation of asparagus and the improvement of certain strains of vegetables. His endeavor to develop a better type of greenhouse lettuce has not yet given the desired results.

Professor Koon has administered the affairs of the Market Garden Field Station. His weekly trips to Amherst have maintained an essential bond between the sub-station and the college. In addition to this he has served in the capacity of Extension Specialist in Vegetable Gardening. His major extension project is the Grading and Standardization of Vegetables. The Extension Specialist and the station staff edit a monthly publication, the Market Garden Field Station Journal, which reaches 1900 vegetable growers. The Annual Field Day meeting at Waltham was attended by nearly one thousand persons interested in the vegetable growing industry.

Administrative Relationships.

When in June 1924 you asked me to assume the duties of the chief executive of the College, it was with the definite understanding that we were to try to clarify the administrative situation that had resulted in the resignation of President Butterfield. Since 1916 he had been trying to administer his office in the face of new legislation affecting more or less all state institutions and departments. Despite these laws: the control over the state institutions by the Supervisor of Administration (1916), the new relationship established with the Department of Education (1919), and the later control of the Commission on Administration and Finance (1922), he contended and insisted that he was primarily, if not solely, responsible to the Board of Trustees. He knew, moreover, that the legislators who had written the Consolidation Law (1919), which "placed" the Trustees in the Department of Education, had stated definitely that the powers of the Trustees and the control of the College by them would not be impaired in any important particular by the new arrangement. The laws establishing the Trustees as a governing body were still on the statute books and he maintained to the end that until they were repealed they were in force.

Nevertheless, it soon became quite evident to him that the latest legislation (1922) governing printing, personnel and purchasing through the Commission on Administration and Finance did after all seriously affect the powers of the Trustees.

Final decisions on these matters were not with him nor with the Trustees but with officials in the Commission on Administration and Finance whom, he knew, could not possibly understand the full significance of many of the matters placed before them for adjudication. He later learned that both by action and by speech, they considered the Commissioner of Education as under the law actually "in charge of the College." He saw the former powers of the Trustees and of himself reduced to uncertain and hesitant recommendations. Necessarily, administration became increasingly difficult and trying to him under the new régime, and efficient administration, he felt, was not possible under it. He protested vigorously and often against what he called "the system," and finally, finding conditions unbearable, he resigned.

In his last report to your Board he said: "We are not, however, reconciled to the essential unsoundness of the present scheme of centralized control of expenditures." "I do not like to continue to protest against the present methods, as I have done every year since the system was established." "I cannot exaggerate its seriousness. I assure you that many of us who come into closest contact with these administrative relationships have reached nearly the limit of our endurance." "The essence of the reform we desire is that you as a Board of Trustees shall have your power of control of the College restored to you, that it shall be specifically recognized that neither the Commissioner of Education nor the Commission on Administration and Finance shall have more than advisory and recommendatory powers." "We believe that the Trustees should have full power to decide the scope of our work; the type of expenditures that are justifiable; to employ members of the staff and to fix their salaries. We believe that this power should be final and not subject to veto on the part of any of the other State officials. There is no question but all these powers should be held by the Trustees subject to legislative authority and to such checks, accounting, and reviews as may be demanded by sound public policy."

The Alumni aroused by the loss of the President and by the difficulties which had caused his resignation, passed unanimously the following resolution at the annual meeting of the Association at Commencement:

"*Whereas:* We the Alumni of the Massachusetts Agricultural College believe that, in order to maintain our college as a first-class educational institution of collegiate grade; to administer the college efficiently and with true economy; to keep high morale among the teaching staff, the Trustees of the College should be given authority to exercise full and absolute administrative responsibility of the college; decide upon expenditure of legislative appropriations; employ members of the staff and fix their salaries; determine educational policies, — perform in fact all the functions of a responsible governing board; therefore, be it

"*Resolved*, That a committee known as the Committee on Administration of the Associate Alumni be appointed to draft and introduce into the next session of the legislature such a bill as will secure such changes in existing laws as may be necessary to secure to the Trustees the authority above mentioned."

In the following August a representative meeting of the farmers' organizations of the State met in Worcester to consider the situation. There was much publicity in the press. The editorial comment was distinctly favorable to a larger freedom of control by the Trustees. There was also a great deal of agitation for legislation. Throughout this critical period your Board continued patiently to hope that the situation would be eased in time, without drastic action. Soon afterward, therefore, you again deliberately adopted a policy of patience and waiting, believing that possibly a new Executive and a new Chairman of the Commission on Administration and Finance might work out agreements and undertakings that would greatly relieve, if not completely solve, some of the more troublesome administrative difficulties. You were agreed, however, that if this policy did not succeed, then a solution by legislation would have to be sought.

Though I was from the beginning firmly of the belief, as you know, that legislation was necessary and inevitable, I gladly acquiesced in your judgment and during the past year I have faithfully tried to carry out your will. I think I have been patient and, if I may say it, long suffering. I have tried to see these problems from the other side as well as from ours. I have been treated with the utmost courtesy and good will by all concerned. I think I have been taught, too, to appreciate the difficulties that other state agencies have to meet in carrying out their purposes. Nevertheless I must report to you that the sum total of accomplishment is entirely negligible, and I am more than ever convinced that separate agreements of any permanent significance, cannot be arranged under present conditions. The great obstacle is the fear of precedent, or of opening the way for similar requests from other institutions. It is probably just as well. Arrangements and understandings are at best mere palliatives. They settle nothing permanently. Had I been able to perfect the most satisfactory of agreements, the law of consolidation, nevertheless, would still continue to stand above you ready to challenge your control of the institution at any time, and you would have to continue to face the inevitable changes in the personnel of the administrative offices at the State House. A great institution like ours should have its control firmly planted upon as sure and safe and as permanent a basis as possible.

By this time I have had sufficient opportunity to know at first hand the many duties and responsibilities of the executive office. Has it been a satisfying experience? Has there been possible a man's pride in the work? I wish I were able to say that there has been. I am told that there may be very real and profound satisfaction in such leadership despite the multiplicity of detail and problem necessarily inherent in so intricate and varied an organization. But when these duties have to be performed under conditions of constant uncertainty; uncertainty of authority, uncertainty of salary adjustments, uncertainty of salary increases, uncertainty of the employment of necessary services, uncertainty of adequate printing (so important an item in an institution of our type), uncertainty of delivery of printing and of goods, uncertainty as to what may be printed and what may not be printed, uncertainty as to our own ability to fulfill important obligations, to confer with Federal colleagues, and a mass of other uncertainties of a similar nature, how can there be any satisfaction except the one of having done one's best in an impossible situation? Furthermore, when one sees this constant state of uncertainty result in deteriorating morale among his most earnest and conscientious subordinates how can there be any pleasure whatever in the labors of such an executive? Under the most favorable conditions the task of administering an institution of as varied character as ours would demand all of the executive's thought and the maximum of his time and resources. But when it has to be done under the conditions which now obtain, is there any possibility whatever of doing the task well?

It is needless for me to say that I wish this sort of thing should not have to be said. Those of you who know my disposition know that there is no pleasure in it for me. But when the welfare of a great institution is at stake and a crisis in its administration has been reached, one's personal pleasure is not to be considered. The time has then come for plain speaking and action.

The fundamental defect, or evil, in the present situation centers in the minute and exacting control by the Commission on Administration and Finance one hundred miles away. The condition of uncertainty just referred to is due solely to the lack of authority by those who are close to the job, and therefore by those who know. Practically everything has to be referred to the Commission. It has the power to set aside the carefully worked out recommendations of responsible men like the Director of the Experiment Station, the Director of Extension, and the President of the College.

If this sort of thing is to continue indefinitely, I frankly cannot see what functions the Trustees have to perform excepting purely advisory functions. Under such circumstances I do not see how your interest can possibly be long maintained. Nor do I see the need of the Presidency at all as ordinarily conceived. A deputy or agent, responsible directly to the Commissioner would serve as well. If the Supervisor of Administration was right when he said that the Head of the Department of Education is actually "in charge of the Massachusetts Agricultural College" let it be so understood and publicly admitted. If the Head of the Department is the only officer with whom the Commissioner will "confer and advise about the affairs of the College," let us all so understand it. Let us stop playing at the game as though the responsibility was solely ours. Let it be frankly and openly proclaimed that the President is directly responsible to the State House and that the Trustees are a purely advisory body, and let the law so express it. That would be a perfectly logical and consistent result both of present practice of the Commission on Administration and Finance and of the expressed statement of policy. In this way unnecessary links in the chain of administration would be eliminated, the whole machinery simplified, and money saved to the State. Since this is the logical consequence of present tendencies, in any event, why not face the fact squarely. The issue is before us again, gentlemen, and it is the old and persistent issue: "Shall the Trustees have sufficient power to manage the institution effectively or shall this power be exercised by other and distant agencies?"

Let us remind you that the control of the institution for over fifty years resided in an independent governing board of Trustees responsible to the Legislature. The competency and efficiency of your kind of control has been proved. I believe that it should be continued. The Massachusetts Agricultural College is a great dynamic public service institution; it deals with the great fundamental and basic industry; it serves a wide and far-reaching constituency, upon the efficiency and prosperity of which depends the welfare of the whole State including its industries, and it has entrusted to its care a type of youth second to none in the Commonwealth. I believe that the best interests of a great institution like this are best served when it is governed at all vital points by a group of unselfish and public spirited citizens like yourselves, who by constant and intimate contact with its many problems and purposes can best understand and therefore best direct its policies and control its destinies.

Let it be clearly understood that there is implied in this contention no objection to the budget method of controlling state finances. The budget idea is sound in principle and theory: it is the only business way of handling appropriations. It is an infinite improvement over the old hit and miss method of appropriating funds, and it has come to stay. But a budget system may be good or bad and a good system may easily be perverted. As I understand it a sound budget arrangement aims to check waste and extravagance and to save money primarily at the point of appropriation, not at the point of expenditure. Our present system controls at both points; moreover, it controls expenditures in the most minute and rigid manner. After a budget has been scrutinized and approved by the budget commissioner, the ways and means committee, and the legislature, its grants of money should not be tied up by a machinery of control that allows no latitude or freedom in expending them, so long as the total does not exceed the total of appropriations. No executive can object to a budget control that says in substance: you may have so much money for this purpose, and no more, you may have so much and no more for that. But serious objection can be raised against a budget control that says you can only pay this much and no more under any circumstances for this specific service; you can only pay for this item so much and only so much. That kind of control should be questioned and it should be questioned not only because it injures the efficiency of administration, but because it jeopardizes the whole budget scheme. The best budget plan may not be able to stand that kind of strain. In that respect, a careful study leads me to say that Massachusetts has gone farther than any other state in the union.

During this year of administration I must frankly state that I have seen my judgments and recommendations as an executive, over-ruled or set aside. I have seen important printing arrive too late either for effective use or for any use at all. I have seen requests for salary adjustments of a delicate and urgent nature questioned and refused. I have seen travel requests of an important and obligatory character rejected. I have had to travel to Boston in order to explain and urge minor matters that could not be understood, and that ought not to have encroached upon my time. I have seen prospective candidates for important positions hesitate, and even refuse, to join the service of the State primarily because of the existing machinery of far away control. I must confess further that I have seldom if ever been made to feel that I was a desirable and helpful public servant rendering a necessary and effective service to the citizenship of the Commonwealth.

Such a situation, I am sure you will say, is intolerable. It is intolerable — judged by any standards of conscientious and responsible administration. It, therefore, ought to be ended. I do not blame the men who are in charge of this control — not in the least. They have always been courteous and frank. The trouble lies in the fact that they are tied up by rigid rules and regulations and are trying to administer a scheme based upon a fundamentally wrong principle. The control of the expert by the inexpert has never worked and it never will. What they are trying to do is something that no group of men can possibly do satisfactorily anywhere. You cannot control any efficient organization, much less a sensitive organization of trained educators, by a card system one hundred miles away, and get results. You cannot control the man who knows by the man who does not know and expect efficient administration and good service. It cannot happen. And it cannot happen because the principle is wrong through and through and the theory unsound. I believe therefore, that it is our bounden duty to press immediately for relief and I see no way to do it effectively except by appropriate and definite legislation. On this account, therefore, I believe that the Alumni and friends of the College are completely justified in joining with you in pressing for such legislation as will restore to you power sufficient to permit you to continue to exercise responsible authority over the College and I have faith to believe that the people of the State and their representatives will agree with me.

EDWARD MORGAN LEWIS,
Acting President.

LEGISLATIVE BUDGET FOR 1926.

Projects for Permanent Improvement.

1. Men's Dormitory, $150,000.

For many years the Trustees have had before them the problem of providing dormitory facilities for a portion of the men students attending the College. The demand for a dormitory has become more urgent yearly. For several years the request for a dormitory was included in the budget. In more recent years other projects have appeared more pressing and the item for a dormitory has been omitted. The Trustees are again presenting as the project which in their judgment is most needed this year, an item for $150,000 for a Men's Dormitory. This will be located south of South College on an existing steam main and adjacent to other service lines. It is proposed to use this dormitory chiefly for freshmen. With proper supervision the housing of freshmen on the campus will undoubtedly be to the scholastic advantage of these boys. The dormitory will accommodate approximately 100 students; by charging a rental somewhat less than that charged in private houses off the campus, it is estimated that a return of from 2% to 3% can be made to the State on this investment.

2. Horticultural Manufactures Building, $60,000.

The importance of utilizing various by-products of the farm which formerly were wasted, such as fruit and vegetables, was emphasized during the war, and under the direction of Prof. W. W. Chenoweth of this institution farmers came to see whereby this saving could to advantage be made permanent. In order to give adequate instruction in the preservation of fruit and vegetable products, a new laboratory building is essential. The plans provide for a one-story building of inexpensive construction, which will furnish laboratories for the various phases of this work.

The pressing need for this building is now generally understood. However, some of the principal considerations may be recapitulated as follows:

(*a*) The department of horticultural manufactures now has its work widely distributed in four buildings, viz, Flint Laboratory, Wilder Hall, French Hall and a workshop on the hill near the cold storage plant. This wide scattering of the work is obviously very detrimental to its objective.

(*b*) The principal teaching is done at Flint Laboratory in rooms which were designed for use by the dairy department. The dairy department needs these rooms and would like to see the department of horticultural manufactures cared for elsewhere as soon as possible.

(*c*) The present quarters are entirely inadequate for the teaching work. On account of the limited space the department has been compelled to refuse admission to numbers of students. This is perhaps the only department in the institution which has been compelled frequently to refuse admission to students on account of lack of space. All the teaching could be much better organized and more efficiently conducted in a new building designed for this particular work.

(*d*) It is highly desirable that vigorous research work be undertaken at the earliest opportunity in the field of fruit and vegetable preservation and the manufacture of by-products. A strong demand exists for this work among fruit growers, but the subject is equally important to all consumers of food in Massachusetts.

(*e*) The department is now carrying on important extension work, but these extension projects need to be strongly supported by effective work at the college, and especially by well-directed research work.

(*f*) The Massachusetts Fruit Growers' Exchange Association, the Boston Market Gardeners' Association and other organizations have urgently requested this proposed building. This demand from the fruit growers and vegetable growers should be squarely met.

3. Additional Land for Cranberry Station at East Wareham, $1,000.

The total area of land, the purchase of which is contemplated by this item, is sixteen acres in the larger parcel; one acre, forty rods, in the smaller. The latter area is needed for the purpose of straightening the present boundary and preventing possible undesirable neighbors. The former area is required for three purposes, namely:

As source of sand for sanding the bogs.

Turf for building dams, dikes and embankments.

An area of some eight acres, a part for enlargement of the blueberry plantation's work, another part for testing new varieties of cranberries, and engaging ultimately in formal breeding work.

4. Roads and Walks, $11,000.

In order to provide improved roads for the main thoroughfares of the campus and to institute permanent walks it is proposed to build small sections of each from year to year. In 1926 it is desired to extend the macadam road started in 1923, a distance of 1,800 feet, from the Library Building to the Power Plant. This section carries the heaviest traffic which comes to the campus and the present dirt road is entirely inadequate, especially during the seasons of frost and of heavy rains.

The estimate of $10,000 is for a 5 inch crushed rock foundation with a 3 inch bituminous bound surface. It is also proposed to build a cement walk from South College to the Drill Hall, a distance of approximately 600 feet, costing $1,000.

5. Women's Gymnasium and Equipment, $16,450.

With the increased number of women students attending the College, the need of a women's gymnasium becomes imperative. With the appropriation here requested it is proposed to erect a wooden frame building adjacent to the present Women's Dormitory. Placed in this location it will be unnecessary to duplicate dressing rooms and shower baths. The amount requested will provide for the necessary equipment for the building.

6. Living Quarters for Foreman at Tillson Farm, $6,000.

Recently the barn cellar on the Tillson Farm was converted into an incubator cellar by repairing the walls and constructing a suitable roof. These repairs, however, have been partial and it is now proposed to raise the roof in order to provide a two-story building. The upper floor will furnish living quarters for the foreman and the main floor will be used as an experimental laboratory, egg room, operating room, office and shop. These improvements have already been delayed beyond the point of economy in operation.

7. Grading Area South of Athletic Field for Tennis Courts, $10,500.

In order to amplify the present inadequate facilities for outdoor games it is proposed to construct 10 tennis courts on the area immediately south of the present enclosed Athletic Field. The grading contemplated is on the basis of the permanent future development of the enclosed area. The expense for grading, surfacing, fencing, etc., is $10,500.

8. Repairs to Physics Building, $4,000.

The building now occupied by the Department of Physics is of frame construction and was one of the original buildings to be erected on the campus until the College opened in 1867. Very little money has been put into this building during the past ten years. The building needs a general overhauling, certain parts of the construction strengthened and various new fixtures installed. The appropriation of $4,000 will in the opinion of the Superintendent of Buildings meet the needs for putting the building in good repair for several years' use.

9. New Steam Line, East Experiment Station to Microbiology Building, $4,775.

This project contemplates replacing a section of underground pipe line which is now in poor condition. The new line would be 385 feet shorter then the present one, thus effecting greater economy in operation.

10. Practice House — Home Economics, $21,000.

A farmhouse for practice work and demonstration purposes is considered an essential in the development of the resident instruction in Home-Making. This house should be arranged for a moderate sized family, living on a modest income. The project here submitted contemplates utilizing a farmhouse belonging to the College and located close by the Women's Dormitory. In many respects the house is now in poor repair and considerable money should be spent on it whether or not it is used for this purpose. The project also contemplates fitting up a shed now attached to the house for the purpose of providing facilities for an instruction room in Clothing. The project also provides for erecting a cottage for the farmer now occupying this house.

11. Gymnasium, $150,000.

A gymnasium has for many years been considered as one of the most pressing needs of the institution. The present so-called Drill Hall offers no facilities whatever for gymnastic work or for other organized forms of physical education. The building is unsuitable even for the practice of basketball, which is the only use to which the building is now put. The locker rooms and toilets adjoining the Drill Hall floor are extremely unsanitary and any improvement in their condition is practically impossible. It is proposed, therefore, with the appropriation here requested, to begin construction on a new building for physical education purposes. This appropriation will provide the basement of the complete Physical Education Building — this basement to include large locker room for the accommodation of recreational classes as a dressing room with locker for each man; several small rooms without lockers as dressing rooms for different teams or groups; a drying room where exercise equipment may be thoroughly dried between the times of practice; shower rooms and toilets sufficient to accommodate all those using the building; swimming pool, and filtration plant. This basement to be covered with a temporary roof until such time as the remainder of the building may be constructed.

REPORT OF THE DEAN.

During the year just ended the work of the Dean's and Registrar's offices was administered by the same Acting Head. This meant a very heavy year. It also called for a rather careful study of the duties of the two offices to determine the most effective plan of organization along permanent lines. A close coördination of the work of these two offices, which is in many respects very similar, will result in more effective administration at a considerable saving in time and money. The experience of the year will be of great value in reorganizing the two offices when the opportune time comes.

The problem of absences, more or less of a nightmare, in the life of any Dean, has never been less vexing since I have been connected with the office. The no-absence regulations for Freshmen and Sophomores appears to develop habits of regular attendance and punctuality in explaining necessary absences. These habits together with the natural interest the student has in the work of his elective courses seem sufficient to carry him during the last two years. It is now only the rare exceptional offender which the Dean is required to handle personally. The plan of daily absence reports for all classes has been put into effect this year.

The advisory group for Freshmen was made up of the following members of the staff whose unselfish and telling work was much appreciated:

Raymond Halliday.	C. A. Peters.
B. F. Jackson.	F. P. Rand.
A. N. Julian.	Paul Serex.
M. O. Lanphear.	Miss Helen Knowlton.
Wm. L. Machmer.	Miss Edna L. Skinner.

Some progress was made in taking care of those students barred from the regular military and physical education courses on account of physical disability. These students were given a special examination by a competent physician who prescribed the kind and amount of exercise suitable for each individual. The student was then asked to follow directions and report at regular intervals to the Director of Physical Education. Only the lack of suitable equipment prevented us from making this work of maximum effectiveness.

Fifty-seven members of last year's Freshman class failed to continue their work as Sophomores this September. Of this number thirteen are still in college as members of this year's Freshman class. Twenty-one left either for financial reasons or because they wanted to go to work and saw no special reason for making the sacrifice of time and money. Ten transferred to other institutions, two are in the two-year course here, and eleven were distinct failures scholastically. These statistics give some idea of the character and variety of problems which the Dean's office is required to handle constantly; they also show that scholastic difficulties alone do not account for the rather high mortality of the first year students.

The spirit of the student body has been excellent. Through strong leadership and the willingness on the part of the representatives of the student body to assist the administration, the program of the Freshman-Sophomore encounters at the beginning of the fall term was curtailed very materially. It would be exceedingly hard to find anywhere a more generally contented student body and one more willing to sacrifice apparent personal advantage for the good of the group.

Naturally we still have problems. Among these are:

(*a*) A general reconstruction of the curriculum so as

1. To reduce the number of required hours the student must carry per term.
2. To bring about a closer coördination of courses.
3. To eliminate some courses with small enrollments.

(*b*) The raising of the standard of scholarship — a problem as old as the college itself.

(*c*) The proper housing of our student body. The proposed new dormitories, when allowed by the legislature, will help very materially in solving this problem.

(*d*) A more effective advisory scheme. There is at present too much difference between the requirements and administration practices of the major advisers.

Viewing the work of the year as a whole one would call it good. Its weak places will be strengthened and its successes give us the greatest encouragement in carrying on.

Wm. L. Machmer,
Acting Dean.

REPORT OF THE DIRECTOR OF THE EXTENSION SERVICE.

Agriculture and rural life in Massachusetts continue in rapid transition. Manufacturing industry competes with agriculture for man-power. Hired farm laborers and owners of poorer farms have found employment in town more attractive. Markets pay more for quality products than ten years ago, and often pay less for poor products than ten years ago. Those farms which cannot produce a quality product are being crowded out of production. We are developing a more highly specialized agriculture with larger capital investment per unit.

These changes bring greater demand for service from extension forces. County agents cannot go to original sources for up-to-date materials: the specialists find it necessary to take more time than formerly to prepare the latest results of research in usable teaching form. Leaders in farm organizations look to the College for interpretation of changes and trends in agriculture. In meeting these calls the Experiment Station staff and resident teachers have given generous and valuable coöperation.

Improved highways have enabled many city workers to live in the country. The material comforts of city life are penetrating the country, and increasing the willingness of intelligent and progressive people to remain in country homes. We receive many calls for help in planning small farm businesses which are to be carried during spare time as secondary sources of income.

One of the greatest services of extension work is to meet emergencies. In our judgment, however, it is more important to prevent emergencies, if possible, than to meet them, and this is best accomplished by widespread teaching of the preventive methods. Such teaching is to a degree prosaic, tedious, and certainly non-spectacular. It is, after all, the most important part of our work. This we believe we have accomplished during the year just closed in greater measure than ever before.

The year has been notable for the continuity of staff service, with a record of but three resignations. Miss Mildred L. Wood, Specialist in Nutrition, Mr. John A. Crawford, Editor, and Mr. John B. Abbott, Specialist in Agronomy, resigned during the year. Miss Wood is succeeded by Miss May E. Foley, and Mr. Abbott by Mr. John P. Helyar. Mr. Robert D. Hawley has taken over the work of the editor, and Mr. Earle S. Carpenter has been appointed to assist Mr. Hawley in work on exhibits and extension courses. Work has been interrupted much less than in any recent year. We have been fortunate in having few changes in clerical staff. The county staffs have also had few changes. New agricultural agents have been appointed in Berkshire, Essex, and Norfolk; new home demonstration agents in Barnstable and Essex, and a new club agent in Berkshire.

Before Mr. Crawford left the position of Extension Editor, a great deal of educational material was furnished to the daily and weekly press and other publications. This work has lagged seriously since Mr. Crawford's departure. Publication of our basic literature has continued, but has not kept pace with either the demand or the plans made for it. Farm and Home Week in 1925 offered the most effective program ever presented. Correspondence courses have lagged because of insufficient personnel and the difficulties of insuring adequate teaching facilities. It is much to be hoped that by re-arrangement proper support can be given to our courses within the next few weeks. Radio courses are a new development. The opportunity is almost beyond imagination. The Extension Service is coöperating with Station WTAG in Worcester and Station WBZ in Springfield. We look for greater rather than less work of this kind. Returns on the poultry course broadcasted from WBZ this last spring were most appreciative. The supervisory members of the staff have kept in touch with the Boards of Trustees for County Aid to Agriculture, and report more active and effective interest on the part of these Boards. All told, the year has been devoid of spectacular features, but has marked excellent progress in systematic teaching.

Extension work is promotion of sound growth and development; we cannot expect the achievement of full growth in a single year. The extension projects as built up through years of study and analysis have undergone no great change in 1925. We have continued to work with commodity associations, and have found excellent co-operation from them. Among these commodity associations are the Massachusetts Association of Certified Poultry Breeders, the local and county poultry associations, the Massachusetts Fruit Growers' Association, the Boston Market Gardeners' Association, the Cape Cod Asparagus Growers, the Association of Co-operative Dairies, and others.

The combined animal husbandry-agronomy-farm management project, dealing with the dairy industry, has continued effectively through the year. Probably the greatest progress has been made in the forage crops phase of the program. Some gains have been made in feeding practices. A revived interest in cow test associations is evident and in their modified form these associations are more effective than ever.

The poultry project has seen the satisfactory establishment of a Massachusetts Association of Certified Poultry Breeders, and general progress in educating the rank and file of poultrymen in better sanitation. Much special work was done during the epidemic of fowl plague, which happily made little appearance in Massachusetts, but was a real menace on the North Atlantic seaboard. By arrangement with the Veterinary Laboratory, a great amount of diagnostic work was done which assisted materially in keeping the poultry industry safe.

During the year producers of milk have been encouraged. With the recovery of milk prices has come optimism, and the despair of a year ago has quite disappeared. Many more dairymen are interested in better feeding and management than a year ago.

Quality product is the goal toward which all efforts are being bent in our pomology work. It is useless to discuss re-capturing our own markets from western fruit until we have a sufficient quantity and quality of fruit with which to hold these markets. The year has shown improvement.

The Boston Market Gardeners' Association has co-operated with the Market Garden Field Station in Waltham in establishing standards for vegetables. These standards are being observed by leading growers. It is too early to judge the effects in the market. This industry, quite as much as any, needs the most painstaking reduction of producing costs, the only basis of profit under present competition.

The specialist in horticultural manufactures has met more demand than ever for work in farm storage; particularly in developing plans by which growers can build inexpensive storage that will effectively keep fruit over a much longer marketing period. Manufacture of quality horticultural products for sale continues in small units but shows growth, with increasing numbers entering the field.

Arrangements have been completed by which extension work in farm forestry is undertaken; the co-operating parties being the Massachusetts Agricultural College, the United States Department of Agriculture, and the Massachusetts Department of Conservation. The Commissioner of Conservation has very generously released part of the time of three men in the service of the State Forester, including the State Forester himself, so that the equivalent of more than the full time of one man is now spent in extension work in Farm Forestry. This work is organized through the college and county extension services.

The most pressing economic situation that has developed during the year has been in the tobacco industry. High prices for the past six years have caused increase of acreage and production, so that for five years ten million pounds per annum more tobacco have been produced than the markets require annually. The extension staff are being pressed by many requests for counsel in meeting this situation. Special publications are about to be issued dealing with the use of land which is taken out of tobacco production.

A part of the time of Mr. Markuson in rural engineering has been given to extension problems in that field. We appreciate this service as it has been necessary to decline many requests in the past through lack of personnel with which they might be met.

Home economics teaching has followed its prior well organized plans. Local groups are organized. These send leaders to a central point where training is given to them by the county home demonstration agent or the state specialist. These trained volunteer leaders then return to their local groups and transmit the information which they have received. The leader-training plan was under great suspicion when it was first undertaken, but has proven workable; it is the only basis on which extension work may be expected to cover its entire field. The work in both clothing and nutrition has followed this trend. The work in home management has been crippled by lack of a specialist, so that no leader-training work, as such, has been undertaken in this project. Demands from the women of the state are quite as strong as ever for this work, and we are still unable to meet them.

Junior extension work or 4-H club work has continued its substantial improvement as to quality of work, maturity of club members, and numbers effectively reached. The deflation point was reached some three years ago, when the wartime spectacular and unimportant phases of club work were pretty well sloughed off. Since that time numbers have increased, and quality of work has improved.

The greatest needs of the extension service for the next year are more ample maintenance funds, and a specialist in Home Management. We have an efficient staff whose usefulness depends on the adequacy of the tools in their hands. It has been necessary to curtail our output of printed material, and to decline opportunities to co-operate in educational exhibits for lack of funds. A steady demand for home management service has been voiced for several years. The project cannot develop in the counties until a trained specialist prepares teaching materials and perfects the abilities of the home demonstration agents.

John D. Willard,
Director of the Extension Service.

REPORT OF THE DIRECTOR OF THE EXPERIMENT STATION.

The outstanding development of the year just past was the passage of the national Purnell Act, which brings to the Station an increased grant of federal funds. This has made possible the institution of work for which there has long been need, but which the Station has been unable to undertake because of a shortage of funds. The terms of the Act make practically obligatory the conduct of research on a regional rather than on a localized state-wide basis. In effect it represents a federal appropriation for the common good which operates through the individual experiment stations.

The first project undertaken was a joint co-operative survey of the New England apple industry. This was organized on the basis of a section-wide project, but with the work of each state carried on under the supervision of the agricultural experiment station concerned, with the whole work correlated through the efforts of the New England Research Council on Marketing and Food Supply. The objectives of the study were several in number, the most important being that of giving to our orchardists better opportunity for planning to meet the needs of a definite market. In an industry in which production is deferred many years after the initial planting, a study such as this is peculiarly necessary and ultimately most profitable.

Supplementing the survey study the New England plan calls for other studies to assist New England in holding one of its great agricultural enterprises. Massachusetts' participation in the plan includes a study of the export demand for New England apples, and a study of the competition of the New England product with that raised elsewhere. It is also planned to inititate comprehensive studies of the utilization of cull and surplus crop through manufacture and preservation.

As regards future work under the Purnell Act, the spread of co-operative selling organizations in New England makes necessary an intensification of economic study with reference to agriculture. The present deplorable situation in the Connecticut Valley tobacco industry may serve as an illustration of a danger to which all selling organizations are exposed, and one which they are incapable of meeting unless served by a thorough-going research agency. The difficulty which is being met in the tobacco industry shows the impossibility, in a country where expansion of production is still possible, of any organization keeping monopoly control of production. Past history, however, shows the wastefulness of a system in which production is not gauged by the needs of the market. The object of much of this work, therefore, is to help our organized agricultural industries in their task of determining extent of production by the needs of the market.

In addition to the above, the Station is instituting what it hopes may prove to be a comprehensive study of the competitive position of the more important farm enterprises of the State. It expects to determine the conditions under which Massachusetts farmers may expect to hold their own over a period of years in competition with other farmers who reach the same market. In fact, had such a study been made five years ago it would be of inestimable help in meeting the present emergency in the Connecticut Valley.

During the period in which the federal Purnell fund is increasing its annual appropriations, the Station does not intend to ask increased financial support from the State.

B. Haskell,
Director of the Experiment Station.

REPORT OF THE DIRECTOR OF THE GRADUATE SCHOOL.

Inclusive of the summer quarter there have been registered in the Graduate School for the past year ninety-one students. Of this number, twenty are teaching in the public schools of this state, and forty-five are connected with colleges and universities. The remainder are widely distributed vocationally.

It is characteristic of graduate students that many of them do not devote their entire time to graduate study, largely because they must earn their livelihood; accordingly they have responsible positions and have to confine their graduate efforts to such time as is at their disposal. What work is done by such students is of excellent quality. They are serious in their graduate undertaking and are diligent and persistent in attaining their ends. That students who can give only part time to their studies can be stimulated by contact with graduate study, make progress in their field of endeavor, and receive the benefits derived from institutional connection, must ever be regarded as one of the greatest services of this Graduate School.

Three students completed their studies for the master of science degree this year. They are —

Miss Eleanor Frances Chase who presented a thesis on "The Phloroglucinol Furfural Reaction."

Mr. Henry Louwsma who presented a thesis on "The Determination of Iron in Nutrient Solutions and its Rôle in Plant Metabolism."

Mr. John Dayton Willard who presented a thesis on "A Study of the Rural Church in Six Hill Towns of Massachusetts: with Plans for Future Activity and Maintenance."

Charles E. Marshall,
Director of the Graduate School.

REPORT OF THE DIRECTOR OF SHORT COURSES.

During the past year several important changes were brought about in the plan of practice training on farms required of all Two-Year students. The opening date of classes in the fall has heretofore coincided with the beginning of college work. But when the time came to look for training jobs for our students, it was soon evident that college time or class time did not suit farm time. In other words calling students back to classes in mid September, right in the rush of harvesting when their services were most valuable, did not appeal to a good many practical farmers. The protest from various fruit-growers of the state was marked, and many other farmers urged a longer training period.

Once the suggestion was presented the logic of the request could not be denied. In fact, it is difficult to explain why the need for such an adjustment, both from the standpoint of increased experience for the student and a better labor distribution for the farmer, was not earlier felt and voiced. It was finally agreed by the fruit-growers that if students could see them through the MacIntosh harvest it would be a satisfactory arrangement, and not too much time would be taken from the classwork of the first term. Other farm operations, too, would be greatly benefited by the extension. The opening date for the Two-Year course was then set for the first Monday in October, this year (1925) October 5th, and once that assurance was given, student positions for farm training and experience were secured without further difficulty. In fact, I am glad to say that Mr. Paul W. Viets, who supervises and arranges all student placements, found more positions available for Two-Year students, and of a better type for the training desired, than in any previous year.

A fair assumption is that there is a growing appreciation of the aid the College gives in thus placing high-grade labor on the farms of the state. There is an increasing recognition, too, that this service is efficient and discriminating in that a student's qualifications for the job have been carefully studied, and a fair statement of his past experience, skills, and general character is frankly presented to the employer. This is a much more comprehensive survey of the man's ability than the usual employment agency could possibly present. An interesting result of this placement training has been the many happy friendships formed between employer and student, in a number of cases leading to a permanent position after graduation.

It would be showing poor appreciation if we did not state that much of the success attained in our farm practice training should be credited to the excellent living and working conditions provided by farmers employing our students. Nothing will discourage a young man's interest in agriculture more quickly than to have to serve his apprenticeship where poor food, poor lodgings, and poor social conditions, to say nothing of a poor business, indicate a general lowering of living standards. Ideals and aspirations go to smash under such an ordeal. Every reasonable precaution is taken to guard against such situations with our Two-Year students and no position is approved without thorough investigation. We are regularly placing our men on many of the best farms in the state for this important period in their education.

To help show the earning value of this summer farm training for students, — besides its learning value — a careful record of each student's initial wage, increases, and bonuses was secured. Where board and room were provided their cash value was estimated based on actual conditions, in some cases $10.00 per week; in others — and only a few — as low as $7.50. Seventy men completed the full training period of six months with a total labor income of $36,799.50.

Animal Husbandry, 18 men, total earnings		$10,334 00
Average per man	$574 11	
Pomology, 16 men, total earnings		8,400 00
Average per man	525 00	
Poultry, 14 men, total earnings		6,595 00
Average per man	471 07	
Floriculture, 9 men, total earnings		4,425 50
Average per man	491 16	
Vegetable Gardening, 5 men, total earnings		2,706 00
Average per man	541 20	
Dairy Manufactures, 3 men, total earnings		1,695 00
Average per man	565 00	

In presenting these figures it must be borne in mind that students range through all grades between skilled and unskilled, and cash wages varied from $40.00 to $90.00 per month. The classification should not be interpreted to show earning power in any one of the agricultural vocations listed, but is used solely to give a rough average of earnings for each group of students specializing in a certain course.

In connection with this study of student income from training work, opportunity was provided to secure data on graduates of a four-year school of business training. In a corresponding training period in banking, leather, wool, saleswork, and other business jobs, the average gross earnings per student closely approximated the wages of our Two-Year students in agriculture, being but very slightly in excess.

This item is of interest only in connection with the training schemes considered. It does serve to emphasize the financial return to young men in vocational agriculture at an early period in their training, with comparatively little experience and but a slight investment in education, — if the expenses of a four-year course in business are contrasted with the shorter period.

Another adjustment effected in the summer training was the placing of a definite number of credits on the work, to be secured only where satisfactory, intelligent, and interested service was rendered to the employer. Twenty-five credit points for the full period of practice work at the rate of one credit per week, were assigned as a requisite for certificate grade. This rating is being measured by a system of monthly training reports in which the student through carefully prepared questions is required to study the special type of farm business. This arrangement provides a more thorough teaching scheme and insures a fuller understanding of the job than a mere check on mechanical skills and routine work. The farm work is directly correlated with class-room work in this way.

As a final guard against any laxity in developing the essential skills and technique in practical agriculture, no student is registered for his final year's work in classes who has failed to submit satisfactory reports, or has shown an inability to carry on farm work well. A poorly trained group of farm workers is just as much a handicap to the business as a similar unskilled group in any other vocation or trade. It seems desirable therefore to maintain constantly a pretty definite goal in all phases of our work in providing practical agricultural training and in helping the student to gain a full realization of the qualifications for success on the job.

Registration in the Two-Year Course increased nearly twenty per cent, for the year 1925–26, compared with enrollment of last year. Certificates were awarded to fifty-two graduates in June, making a total of 398 students who have completed the full course with credit during its six years of operation. In addition 29 students have completed the One-Year course in Vocational Poultry during the same period.

Winter School.

With the addition of a special course in Fruit-Growing to our Winter School curriculum, the opportunity for securing short, intensive training courses in particular branches of agriculture was further increased.

The ten day courses in Dairy Manufactures were well patronized. The course for Milk Inspectors proved popular and nearly all the leading cities of the state sent official representatives. The value of this training service rendered by the College in bringing about a more uniform system of inspection based upon the latest scientific investigation can not be too fully realized as a health safeguard.

Summer School.

To broaden the scope of training courses provided for teachers of the state, new courses have been provided in "Modern Philosophy of Education," "Methods in Social Studies," and "Nutrition Phases of Health Education."

The subjects dealing with Home Economics attracted many students, especially High School teachers, a good proportion coming from Boston and vicinity. It is worth while to note a growing appreciation among our Massachusetts teachers of the many advantages the College provides in its six weeks summer course.

Finally, I wish to quote from the 1924 report of the Committee on Instruction in Agriculture of the Association of Land-Grant Colleges. "There is . . . a widespread feeling that the large investments of funds in the buildings, equipment and facilities of the Colleges is not justified unless the plan and personnel of these institutions are being used to the fullest extent." It is to be hoped that through the medium of our short-course program, we are helping to justify the investment our citizens have made in their College of Agriculture.

Roland H. Verbeck,
Director of Short Courses.

Table I. — New Appointments.

A. In the Academic Departments.

Instructor in Horticulture: Luther B. Arrington, B.Sc., Massachusetts Agricultural College, 1923.

Instructor in Chemistry: Frederic R. Butler, B.Sc., Worcester Polytechnic Institute, 1920; M.Sc., Clark, 1922; A.M., Harvard 1924; Ph.D., Harvard, 1925.

Instructor in Agricultural Economics: Mary J. Foley, B.Sc., Massachusetts Agricultural College, 1924.

Instructor in German: Paul Keller, B.Sc., Boston University, 1925.

Instructor in Dairying: Merrill J. Mack, B.Sc., Pennsylvania State College, 1923; M.Sc., University of Wisconsin, 1925.

Assistant Professor of Rural Engineering: Miner J. Markuson, B.Sc., University of Minnesota, 1923.

Instructor of Microbiology: Harry T. Mortensen, B.Sc., Michigan State College, 1924.

Professor and Head of the Department of Physics: Wallace F. Powers, A.B. Clark, 1910; A.M., Clark, 1911; Ph.D., Clark, 1914.

Assistant Professor of Landscape Gardening: Leon R. Quinlan, B.Sc., Colorado Agricultural College, 1921; M.L.A., Harvard, 1925.

Instructor in Mathematics: George F. Shumway, B.Sc., Massachusetts Agricultural College, 1925.

Instructor in Agronomy: Orman E. Street, B.Sc., South Dakota State College, 1924.

Instructor in Physical Education: Malcomb E. Tumey, B.Sc., Massachusetts Agricultural College, 1923.

Instructor in Microbiology: Dennis R. A. Wharton, B.S.A., Ontario Agricultural College, 1924.

B. In the Experiment Station.

Assistant Research Professor of Microbiology: Leon A. Bradley, B.Sc., Wesleyan, 1922; Ph.D., Yale, 1925.

Field Assistant in Pomology: Walter L. Cutler.

Assistant Research Professor of Botany: Emil F. Guba, B.Sc., Massachusetts Agricultural College, 1919; Ph.D., University of Illinois, 1923.

Assistant Research Professor of Entomology: Warren D. Whitcomb, B.Sc., Massachusetts Agricultural College, 1917.

C. On Purnell Funds.

Research Professor of Horticultural Manufactures (appointment effective Dec. 1, 1925): Carl R. Fellers, A.B., Cornell, 1915; M.Sc., Rutgers, 1916; Ph.D., Rutgers, 1917.

Assistant Research Professor of Dairying: Arthur W. Phillips, B.Sc., Tufts, 1915; A.M., Harvard, 1921.

Laboratory Assistant in Agricultural Economics: Ruth E. Sherburne, B.Sc., Simmons, 1919.

Assistant Research Professor of Agricultural Economics: Hubert W. Yount, B.S.A., Ohio State University, 1921; M.Sc., Massachusetts Agricultural College, 1923.

D. In the Control Service.

Collector of blood samples, poultry disease elimination: Wilbert D. Field, B.Sc., Massachusetts Agricultural College, 1919.

Analyst, poultry disease elimination: Mrs. Leila Prescott.

Technical Assistant: Harold F. Rowley, B.Sc., Massachusetts Agricultural College, 1925.

E. In the Extension Service.

Supervisor of Exhibits and Extension Courses: Earle S. Carpenter, B.Sc., Massachusetts Agricultural College, 1924.

Assistant Extension Professor of Nutrition: May E. Foley, B.Sc., Michigan State College 1918; M.A., Columbia, 1922.

Extension Professor of Agronomy: John P. Helyar, B.S.A., University of Vermont 1909; M.Sc., University of Vermont, 1912.

TABLE II. — SPEAKERS FOR THE YEAR.

A. Speakers at Assembly for the Year ending Nov. 30, 1925.

1924	
Dec. 4.	Mr. F. F. Rockwell, Bridgeton, New Jersey.
Dec. 11.	Mr. Sumner R. Parker, Amherst.
1925	
Jan. 7.	Mr. Roscoe C. Edlund, Springfield.
Jan. 14.	Professor Warren K. Green, Amherst.
Jan. 21.	Professor Samuel R. Williams, Amherst.
Jan. 28.	Professor Harry E. Barnes, Northampton.
Feb. 4.	Mr. Jewell B. Knight, Arlington.
Feb. 11.	Professor Albert Dickens, Manhattan, Kansas.
Feb. 18.	Student Forum.
Feb. 25.	Rev. Stoyen Vatralski, Bulgaria.
Mar. 4.	Mr. Robindra C. Nag, India.
Mar. 11.	Rev. Ralph A. Christie, Florence.
Apr. 1.	Educational Films, United States Forestry Service.
Apr. 8.	Mr. M. J. Duryea, Greenfield.
Apr. 15.	Professor William H. Burnham, Worcester.
Apr. 22.	Mrs. Margaret Briscoe Hopkins, Amherst.
Apr. 29.	Student Forum.
May 6.	Mayor Edwin O. Childs, Newton.
May 13.	Hon. George B. Churchill, Amherst.
May 20.	Burnham Declamation Contest.
May 27.	Hon. Fred W. Cross, Boston.
June 3.	Professor Paul H. Douglas, Chicago, Ill.
Sept. 24.	Mr. Hugh G. Van Pelt, Chicago, Ill.
Oct. 1.	Mr. George P. Campbell, Shirley.
Oct. 8.	Orrin C. Lester, New York City.
Oct. 15.	Lt. Alden G. Alley, Boston.
Oct. 22.	Mr. Horace D. Taft, Watertown, Conn.
Oct. 29.	President William A. Neilson, Northampton.
Nov. 5.	Rev. John H Nolan, Springfield.
Nov. 12.	Student Forum.
Nov. 19.	Rev. Louis C. Cornish, Boston.

B. Speakers at Sunday Chapel for Year ending Nov. 30, 1925.

1924	
Dec. 7.	Rev. James Gordon Gilkey, Springfield.
Dec. 14.	Dr. William I. Chamberlain, New York City.
1925	
Jan. 4.	Principal Alfred E. Stearns, Andover.
Jan. 11.	Dean Charles R. Brown, New Haven, Conn.
Jan. 18.	Rev. John Haynes Holmes, New York City.
Jan. 25.	Bishop Edwin H. Hughes, Chicago, Ill.
Feb. 1.	President Bernard I. Bell, Annandale-on-Hudson, N. Y.
Feb. 8.	Rev. W. A. Atkinson, Rochester, Pa.
Feb. 15.	Pres. Paul D. Moody, Middlebury, Vt.
Mar. 1.	Rev. John B. Hanna, M.A.C.
Mar. 8.	Rev. Edwin B. Robinson, Holyoke.
Mar. 15.	Rev. Kenneth C. McArthur, Cambridge.
Apr. 5.	Rev. Ralph A. Christie, Florence.
Apr. 26.	Rev. John B. Hanna, M.A.C.
Nov. 1.	Bishop Francis J. McConnell, Pittsburgh, Pa.
Nov. 8.	Rev. James G. Gilkey, Springfield.
Nov. 15.	Rev. John B. Hanna, M.A.C.
Nov. 22.	Rev. John Herman Randall, New York City.

Table III. — Attendance.

	Registration Nov. 1, 1924.			Registration Nov. 1, 1925.		
A. In Work of College Grade.	Men.	Women.	Total.	Men.	Women.	Total.
Graduate Students	53	8	61	42	5	47
Senior Class	79	4	83	90	15	105
Junior Class	99	14	113	83	11	94
Sophomore Class	100	10	110	110	28	138
Freshman Class	153	31	184	140	39	179
Special Students	9	11	20	4	5	9
Totals	493	78	571	469	103	572
B. Short Course Enrollment.						
Two-Year Course, second year	59	8	67	75	9	84
Two-Year Course, first year	85	9	94	93	12	105
Vocational Poultry Course	–	–	–	3	–	3
Two-Year Course, special students	1	1	2	–	–	–
Totals	145	18	163	171	21	192
C. Other Short Course Enrollment.						
Winter School	72	11	83	76	10	86
Summer School	55	89	144	58	113	171
Totals	127	100	227	134	123	257

D. Convention Registration.	**1924.**	**1925.**
Polish Farmers' Day	200	175
Farmers' Week and Annual Poultry Convention	3,000	3,000
Junior Boys' and Girls' Prize Winners' Camp	100	125
Extension Workers' Conference	100	100
Feed Dealers' Conference	40	–
Hampden County Club Members	100	–
Bankers' Conference	20	–
Women's Clubs	80	50
Lawn Day	30	67
Greenkeepers' Day	35	–
Boys' Camp	50	36
School for Veterinarians	–	52
Meeting of Grange Lecturers	–	100
Hampshire County Fruit Meeting	–	35
Tri-State Conference on Clothing	–	50
Middlesex County Club Champions	–	100
Camp Vail Training School	–	40
	3,755	3,930

Table IV. — Legislative Budget, 1925.

Items.	Requested, 1925.	Appropriated, 1925.
Additional land, Cranberry Station at East Wareham	$1,000	–
Refrigerating plant at Paige Laboratory	2,000	–
Culvert for brook	2,505	–
Roads and Walks	10,000	$1,000
Fencing Fruit Plantations	3,000	3,000
Horticultural Manufactures Building	60,000	–
Tunnel, power plant to Stockbridge Hall	38,500	–
Women's gymnasium and equipment	16,450	–
Living quarters for foreman at Tillson Farm	6,000	–
Extension of athletic field area	22,500	–
Other permanent improvements, athletic field area	10,500	–
Tunnel to first pit south of power plant	4,615	–
New Steam line, east experiment station to microbiology building	4,705	–
Livestock replacements	4,000	4,000
Replacement of Cavalry Barn	–	16,500 [1]
Totals	$185,775	$24,500

[1] Granted October 14, 1925 from the Governor's Emergency Account to replace Cavalry Barn destroyed by fire September 3, 1925.

Table V. — Current Account, State Funds.

	Requested 1925.	Appropriated 1925.	Deficiency Appropriation (Balance from 1924).	Expended 1925.	Balance.
Personal Services:					
Administration	$36,650	$35,300	–	$33,173 75	$2,126 25
Instruction	202,871	200,000	–	193,015 01	6,984 99
General Maintenance	132,125	129,000	$15 00	145,718 42	—16,703 42
Experiment Station	82,650	79,200	50 00	79,185 90	64 10
Extension Service	55,975	50,600	–	50,010 08	589 92
Market Garden	7,000	6,000	–	6,836 90	—836 90
Short Courses	62,738	61,500	–	58,364 20	3,135 80
Travel, Office and other expenses	45,000	42,500	462 53	35,787 29	7,175 24
Teaching, lab. supplies and equip.	56,000	56,000	533 34	50,896 18	5,637 16
Experiment Station supplies, equip. and publications	17,850	15,500	75 31	14,817 25	758 06
Experiment Station travel and office expenses	4,500	4,000	29 24	3,374 25	654 99
Extension Service supplies, equip., travel etc.	35,750	33,000	596 70	35,113 46	—1,516 76
Short Courses	11,400	11,400	156 74	10,782 43	774 31
Heat, light and power	65,000	65,000	14,109 55	49,624 52	29,485 03
Farm and Grounds	20,000	20,000	30 36	14,318 80	5,711 56
Repairs, ordinary	25,000	25,000	57 92	30,418 33	—5,360 41
Replacements	25,000	20,000	1,557 64	21,301 88	255 76
Market Gardening	5,000	5,000	6 38	4,187 92	818 46
Fertilizer Law Control	14,000	13,500	–	13,483 42	16 58
Poultry Disease Law	8,500	9,000	6 02	8,917 63	88 39
Milk-testing inspection law	600	600	–	701 92	—101 92
Trustees' Expenses	1,200	1,200	104 28	1,250 93	53 35
Printing Reports	2,000	2,000	904 70	1,667 44	1,237 26
Commercial Feedstuffs	9,000	9,000	–	8,972 84	27 16
Emergency Fund	–	5,000	–	–	–
	$925,809	$899,300	$18,695 71	$871,920 75	$41,074 96

Table VI. — Statistics of Freshmen entering Massachusetts Agricultural College, September, 1925.

A. Home Addresses of Students (classified by Towns and Cities).

Abington	1	Framingham	1	Port Chester, N. Y.	1
Adams	1	Gardner	1	PROVIDENCE, R. I.	1
Agawam	1	GLOUCESTER	1	QUINCY	1
Amherst	10	Great Barrington	1	Reading	1
Arlington	2	Greenfield	9	Richford, Vt.	1
Ashby	2	Hadley	2	Rockland	1
Ashfield	3	Hampden	1	Sheffield	1
ATTLEBORO	1	Hardwick	1	Shelburne Falls	2
Auburn	1	Holden	2	Sherborn	1
Bedford	1	Holliston	1	Shirley	1
Belmont	1	HOLYOKE	7	Shrewsbury	2
Bolton	2	Lancaster	1	SOMERVILLE	1
BOSTON	14	Lincoln	1	Southbridge	1
Braintree	1	LYNN	1	South Hadley	2
BRATTLEBORO, VT.	1	MALDEN	2	SPRINGFIELD	6
Bridgewater	1	MELROSE	3	Stamford, Ct.	1
Brimfield	1	Middleborough	1	Strong, Maine	1
BROCKTON	1	Milford	1	Sudbury	1
BROOKLYN, N. Y.	2	Millis	1	Swansea	1
CAMBRIDGE	1	Milton	1	TAUNTON	1
Carlisle	1	Montague	3	Walpole	1
Chepachet, R. I.	1	MONTPELIER, VT.	1	Wareham	1
Chester Depot, Vt.	1	Monson	1	Watertown	1
CHICOPEE	2	Natick	1	Westborough	1
Clinton	1	NEWTON	5	WESTFIELD	1
Conway	1	Norfolk	1	WEST HARTFORD, CONN.	1
Dalton	3	NORTH ADAMS	2	Westminster	1
Dartmouth	1	NORTHAMPTON	5	West Springfield	1
Dighton	1	Northbridge	3	Williamstown	1
Easthampton	4	Northfield, Vt.	1	Wilmington, Vt.	1
EVERETT	1	Norwalk, Conn.	1	Windsor	1
FALL RIVER	2	PEABODY	1	WORCESTER	5
Falmouth	1	PITTSBURGH, PA.	1	Yarmouth	1
FITCHBURG	1				

B. Home Addresses (classified by States and Countries).

	Number.	Per Cent.		Number.	Per Cent.
Connecticut	3	1.67	Rhode Island	2	1.12
Maine	1	.56	Vermont	6	3.35
Massachusetts	163	91.06			
New York	3	1.67		179	99.98
Pennsylvania	1	.56			

C. Home Addresses (classified by Counties of Massachusetts).

	Number.	Per Cent.		Number.	Per Cent.
Barnstable	2	1.23	Middlesex	29	17.79
Berkshire	10	6.13	Norfolk	6	3.68
Bristol	7	4.29	Plymouth	6	3.68
Essex	3	1.84	Suffolk	14	8.59
Franklin	18	11.05	Worcester	24	14.72
Hampden	21	12.88			
Hampshire	23	14.11		163	99.99

D. Nativity of Parents.

	Number.	Per Cent.
Neither parent foreign born	122	68.16
Both parents foreign born	33	18.43
Father (only) foreign born	7	3.91
Mother (only) foreign born	14	7.82
No statistics	3	1.68
	179	100.00

E. Education of Father.

Common School	67	37.43
High School	56	31.29
Business School	15	8.38
College or University	35	19.55
No statistics	6	3.35
	179	100.00

F. Occupation of Father.

Agriculture and Horticulture	35	19.54
Artisans	56	31.28
Business	37	20.67
Deceased or no statistics	15	8.38
Miscellaneous	15	8.38
Professional	21	11.73
	179	99.98

G. Intended Vocation of Student.

	Men.	Women.	Total.	Per Cent.
Farming	27	5	32	17.88
Landscape Gardening	22	7	29	16.20
General Teaching	11	14	25	13.97
Commercial Chemistry	24	–	24	13.41
Agricultural Chemistry	8	–	8	4.47
Forestry	8	–	8	4.47
Engineering	7	–	7	3.91
Other Agricultural Work	4	–	4	2.24
Floriculture	2	1	3	1.68
Entomology	3	–	3	1.68
Agricultural teaching	3	–	3	1.68
Dietetics	–	3	3	1.68
Religious and Social Work	1	2	3	1.68
Medicine	2	–	2	1.12
Business	2	–	2	1.12
Domestic Science Teaching	–	1	1	.50
Extension Service	–	1	1	.50
Undecided	16	5	21	11.73
	140	39	179	99.92

H. Farm Experience.

Brought up on a farm	36	9	45	25.14
Not brought up on a farm and having no or practically no farm experience	46	27	73	40.78
Not brought up on a farm, but having had some farm experience	58	3	61	34.08
	140	39	179	100.00

I. Miscellaneous Statistics.

Average age (years) 18.86

REPORT OF THE TREASURER

For the Fiscal Year ending November 30, 1925.

BALANCE SHEET.

		Debit.	Credit.
1924			
Dec. 1.	To balance on hand	$37,385 22	
1925			
Nov. 30.	To departmental income	164,794 54	
Nov. 30.	To Receipts from State Treasurer	697,060 46	
Nov. 30.	To refunds to State Treasurer	4,592 26	
Nov. 30.	To Receipts from United States Treasurer	121,868 08	
Nov. 30.	To bills paid by State Treasurer	228,717 72	
Nov. 30.	Refunds transferred to State Treasurer		$4,592 26
Nov. 30.	Expenditures for fiscal year		1,045,009 34
Nov. 30.	Income transferred to State Treasurer		164,794 54
Nov. 30.	Balance on hand		40,022 14
		$1,254,418 28	$1,254,418 28

STATEMENT OF LEGISLATIVE APPORTIONMENT AND EXPENDITURES FOR FISCAL YEAR ENDING NOVEMBER 30, 1925 AND APPORTIONMENT REQUESTED FOR 1926.

	Apportionment for Last Fiscal Year.		Expenditures.		Requested Apportionment for New Fiscal Year.	
College:						
Personal Services	$364,315 00		$389,272 05		$381,104 00	
Maintenance	223,693 70	$588,008 70	163,680 25	$552,952 30	211,000 00	$592,104 00
Experiment Station:						
Personal Services	$79,250 00		$79,185 90		$79,200 00	
Maintenance	19,604 55	98,854 55	18,191 50	97,377 40	19,500 00	98,700 00
Extension Service:						
Personal Services	$50,600 00		$50,010 08		$54,995 00	
Maintenance	33,596 70	84,196 70	35,113 46	85,123 54	36,000 00	90,995 00
Short Courses:						
Personal Services	$61,500 00		$58,364 20		$61,660 00	
Maintenance	11,556 74	73,056 74	10,782 43	69,146 63	13,000 00	74,660 00
Market Garden Field Station:						
Personal Services	$6,000 00		$6,836 90		$8,000 00	
Maintenance	5,006 38	11,006 38	4,187 92	11,024 82	6,000 00	14,000 00
Trustees travel	$1,304 28		$1,250 93		$1,200 00	
Printing reports	2,904 70		1,667 44		2,000 00	
Commercial feedstuffs	9,000 00		8,972 84		10,000 00	
Totals		13,208 98		11,891 21		13,200 00
Fertilizer Law	$13,500 00		$13,483 42		$14,500 00	
Poultry Law	9,006 02		8,917 63		10,300 00	
Milk testing Law	600 00		701 92		600 00	
Totals		23,106 02		23,102 97		25,400 00
Replacements	$21,557 64	21,557 64	$21,301 88	21,301 88	$25,000 00	25,000 00
Emergency	5,000 00	5,000 00	930 64	930 64	5,000 00	5,000 00
Totals		$917,995 71		$872,851 39		$939,059 00
Balance unexpended		–		45,144 32		–
				$917,995 71		

CASH STATEMENT.

	Other Funds.	State Funds.	Totals.
Balance December 1, 1924	$37,385 22	–	$37,385 22
Receipts.			
College receipts from students and others	–		28,683 08
Tuition	–	$5,740 00	
Laboratory fees	–	5,776 16	
Rent	–	17,166 92	
Department Sales			76,357 01
Products	–	68,718 04	
Miscellaneous	–	7,638 97	
Experiment Station			13,613 75
Cranberry receipts		2,241 67	
Chemical receipts	–	301 22	
Miscellaneous	–	11,070 86	
Extension Service			967 95
Correspondence	–	737 90	
Miscellaneous	–	230 05	
Short Courses			3,942 08
Students' fees	–	3,732 08	
Winter School	–	210 00	
Miscellaneous	–	–	
Market Garden Field Station			658 68
Produce	–	658 68	
Feed Law	–	18,240 84	18,240 84
Fertilizer Law	–	15,543 47	15,543 47
Milk Testing Law	–	885 16	885 16

	Other Funds.	State Funds.	Totals.
Poultry Disease Law	–	$5,902 52	$5,902 52
Treasurer of the Commonwealth			697,060 46
Maintenance	–	689,529 67	
Special appropriations	–	2,092 48	
Endowment	$3,313 32		
Department of Education	2,124 99		
Federal Government			121,868 08
Land Grant of 1862	7,300 00		
Hatch Fund of 1887	15,000 00		
Morrill Fund of 1890	16,666 67		
Adams Fund of 1906	15,000 00		
Nelson Fund of 1907	16,666 66		
Smith Lever Fund of 1914	31,234 75		
Short Courses, Federal Project	10,000 00		
Purnell Fund of 1925	10,000 00		
Bills paid by State Treasurer	–	228,717 72	228,717 72
	$164,691 61	$1,085,134 41	$1,249,826 02

Payments.

	Other Funds.	State Funds.	Totals.
College expense			$598,861 44
Personal service	$45,909 14	$389,272 05	
Maintenance	–	163,680 25	
Experiment Station			133,229 26
Personal service	32,856 43	79,185 90	
Maintenance	2,995 43	18,191 50	
Extension Service			117,534 94
Personal Service	30,435 16	50,010 08	
Maintenance	1,976 24	35,113 46	
Short Courses			79,643 70
Personal service	5,172 86	58,364 20	
Maintenance	5,324 21	10,782 43	
Market Garden Field Station			11,024 82
Personal service	–	6,836 90	
Maintenance	–	4,187 92	
Trustees Travel	–	1,250 93	1,250 93
Printing Reports	–	1,667 44	1,667 44
Replacements	–	21,301 88	21,301 88
Commercial feedstuffs	–	8,972 84	8,972 84
Fertilizer Law	–	13,483 42	13,483 42
Milk Testing Law	–	701 92	701 92
Poultry Disease Law	–	8,917 63	8,917 63
Special appropriations	–	–	43,826 86
1923 Chemistry Laboratory	–	5,614 22	
1924 Roads and Walks	–	260 83	
1924 Rural Engineering	–	2,821 70	
1924 Emergency needs	–	5,000 00	
1924 Market Garden Field Station	–	23,004 31	
1925 Roads and Walks	–	1,000 00	
1925 Fencing Fruit Plantation	–	3,000 00	
1925 Emergency needs	–	930 64	
1925 Livestock replacement	–	2,195 16	
Income	–	164,794 54	164,794 54
Refunds to State Treasurer	–	4,592 26	4,592 26
Balance	40,022 14	–	40,022 14
	$164,691 61	$1,085,134 41	$1,249,826 02

BUDGET APPROPRIATION FOR CURRENT EXPENSES FOR YEAR ENDING NOV. 30, 1925.

Personal services:	Appropriation.	Current Year.	Balances.
Administration	$35,300 00	$33,173 75	$2,126 25
Instruction	200,000 00	193,015 01	6,984 99
Maintenance	129,015 00	–	—16,703 42
Departmental	–	73,454 16	–
Farm	–	30,910 90	–
Operating	–	41,353 36	–
Repairs Ordinary	–	17,364 87	—17,364 87
Replacements	–	4,509 60	–4,509 60
Experiment Station	79,250 00	79,185 90	64 10
Fertilizer Control Law	–	10,247 60	–10,247 60
Poultry Disease Law	–	6,876 13	–6,876 13
Milk Testing Inspection Law	–	360 00	–360 00
Commercial Feedstuffs	–	7,211 87	–7,211 87
Extension Service	50,600 00	50,010 08	589 92
Market Garden Field Station	6,000 00	6,836 90	–836 90
Short Courses	61,500 00	58,364 20	3,135 80
Total Personal Services	$561,665 00	$612,874 33	–$51,209 33
Travel	$42,962 53	$5,427 43	$7,175 24
Office and other Expenses		30,359 86	
Teaching and Laboratory Supplies	56,533 34	43,749 73	5,637 16
Minor Equipment		7,146 45	
Experiment Station:			
Supplies and Equipment	15,575 31	14,817 25	758 06
Travel	4,029 24	2,274 78	654 99
Office Expenses		1,099 47	
Extension Services:			
Supplies and Equipment	33,596 70	17,165 02	–1,516 76
Travel		17,948 44	
Market Garden Field Station	5,006 38	4,187 92	818 46
Short Courses:			
Travel	11,556 74	1,436 22	774 31
Office and other Expenses		9,346 21	
Heat, Light and Power	79,109 55	49,624 52	29,485 03
Farm	20,030 36	14,318 80	5,711 56
Repairs Ordinary	25,057 92	13,053 46	12,004 46
Replacements	21,557 64	16,792 28	4,765 36
Fertilizer Control Law:			
Travel	13,500 00	987 47	10,264 18
Office and other Expenses		2,248 35	
Poultry Disease Law:			
Travel	9,006 02	1,224 08	6,964 52
Office and other Expenses		817 42	
Milk Testing Inspection Law:			
Travel	600 00	325 06	258 08
Office and other Expenses		16 86	
Trustee's Expenses	1,304 28	1,250 93	53 35
Printing Reports	2,904 70	1,667 44	1,237 26
Commercial Feedstuffs:			
Travel	9,000 00	663 73	7,239 03
Office and other Expenses		1,097 24	
Total	$912,995 71	$871,920 75	$41,074 96

College Dept.:	Appropriation.	Current Year.	Balances.
Dean's Office	$3,945 00	$3,900 65	$44 35
Executive Order	11,430 21	8,537 04	2,893 17
President's Office	18,405 63	18,740 06	−334 43
Registrar's Office	3,151 49	3,126 25	25 24
Treasurer's Office	19,199 19	18,976 05	223 14
Agricultural Economics	9,315 10	9,346 01	−30 91
Agricultural Education	6,052 50	5,947 93	104 57
Agronomy	6,327 84	6,297 87	29 97
Animal Husbandry	2,246 31	2,208 97	37 34
Beekeeping	2,670 00	2,673 36	−3 36
Botany	11,485 89	11,511 84	−25 95
Chemistry	19,204 43	19,398 15	−193 72
Dairying	39,438 00	37,898 04	1,539 96
Economics and Sociology	2,772 99	2,691 59	81 40
Entomology	9,177 00	9,115 74	61 26
Farm	40,303 86	46,487 23	−6,183 37
Farm Management	5,561 35	5,575 11	−13 76
Floriculture	11,528 90	11,400 98	127 92
Forestry	2,781 42	2,669 15	112 27
Freshman Agriculture	300 00	155 82	144 18
General Agriculture	5,566 37	5,587 54	−21 17
General Expense	190 95	2,470 30	−2,279 35
General Horticulture	17,408 89	16,741 61	667 28
Graduate School	200 00	130 41	69 59
Grounds	10,376 20	10,370 35	5 85
Horticultural Mfg.	7,482 75	7,097 36	385 39
Hospital	4,021 22	4,098 57	−77 35
Landscape Gardening	7,144 28	7,118 30	25 98
Language and Literature	21,943 37	21,767 20	176 17
Library	16,258 62	16,522 84	−264 22
Mathematics	9,695 00	9,667 17	27 83
Microbiology	10,578 39	10,411 64	166 75
Military Science	2,927 40	2,783 02	144 38
Mount Toby	3,500 00	2,074 26	1,425 74
Physical Education	12,270 00	12,329 45	−59 45
Physics	5,170 00	5,323 73	−153 73
Operating and Maintenance	157,356 75	129,447 83	27,908 92
Pomology	11,362 75	11,730 92	−368 17
Poultry	25,462 69	24,583 76	878 93
Rural Engineering	5,069 34	5,062 09	7 25
Rural Home Life	11,008 38	11,316 88	−308 50
Rural Sociology	192 58	92 58	100 00
Vegetable Gardening	6,865 00	6,804 16	60 84
Veterinary	8,923 83	9,000 67	−76 84
Women's Dormitory	3,515 00	4,201 57	−686 57
Zoölogy and Geology	4,020 00	4,033 35	−13 35
Salary Surplus	9,111 24	–	9,111 24
Replacement President's Order	−57 79	–	−57 79
Replacement Unapportioned	2 80	–	2 80
Total College Expenses	$602,863 12	$567,425 40	$35,437 72

	Appropriation.	Current Year.	Balances.
Exper. Station Dept.:			
Administration	$9,552 69	$9,031 75	$520 94
Agricultural Economics	2,615 78	2,600 52	15 26
Agronomy	5,643 02	5,654 47	−11 45
Botany	12,228 36	11,791 17	437 19
Chemistry	14,445 29	14,428 44	16 85
Cranberry	9,520 80	9,570 92	−50 12
Entomology	6,606 43	6,523 73	82 70
Farm Management	250 00	327 91	−77 91
Freight and Express	300 00	413 60	−113 60
Library	775 00	716 37	58 63
Market Garden Field Station	2,688 33	2,688 33	−
Meteorology	1,100 00	1,068 84	31 16
Microbiology	2,318 89	2,306 45	12 44
Pomology	6,919 16	6,676 47	242 69
Poultry	9,986 22	10,169 86	−183 64
Rural Engineering	200 00	83 07	116 93
Station Service	14,897 63	13,770 56	1,127 07
Veterinary Science	3,383 33	3,342 37	40 96
Fertilizer Control Law	13,500 00	13,483 42	16 58
Poultry Disease Law	9,006 02	8,917 63	88 39
Milk Testing Inspection Law	600 00	701 92	−101 92
Commercial Feedstuffs	9,400 74	9,373 58	27 16
Salary Surplus	−788 95	−	−788 95
Replacement surplus	−188 17	−	−188 17
Total Experiment Station	$134,960 57	$133,641 38	$1,319 19
Exten. Service Dept.:			
Administration	$17,679 15	$18,141 46	−$462 31
Animal Husbandry	2,102 00	1,657 49	444 51
Animal Pathology	−	221 87	−221 87
Clothing	2,982 00	2,949 98	32 02
Co-op. Marketing	4,418 73	4,533 87	−115 14
Correspondence Courses	3,511 84	2,436 07	1,075 77
County Agents	2,816 26	2,748 04	68 22
Crop Protection	100 00	−	100 00
Dairying	1,500 00	1,571 37	−71 37
Exhibits	2,057 50	1,860 63	196 87
Extension Courses at College	3,342 95	4,684 64	−1,341 69
Extension Schools	1,503 58	915 98	587 60
Farm Management	2,185 50	1,860 24	325 26
Forestry	−	−	−
Gardening	1,934 00	2,179 05	−245 05
Home Demonstration	3,758 42	3,729 57	28 85
Horticultural Mfg.	3,414 00	3,806 64	−392 64
Household Management	550 00	1,284 39	−734 39
Junior Extension	11,321 81	12,639 52	−1,317 71
Landscape Gardening	100 00	172 05	−72 05
Lectures	400 00	155 53	244 47
Library Extension	250 00	45 75	204 25
Nutrition	3,069 83	3,099 14	−29 31
Pomology	2,722 00	2,936 75	−214 75
Poultry Husbandry	3,396 55	3,467 60	−71 05
Printing	8,376 84	7,630 40	746 44
Rural Engineering	100 00	113 88	−13 88
Soils and Crops	2,289 31	2,282 74	6 57
Salary Surplus	315 54	−	315 54
Replacement Surplus	2 11	−	2 11
Total Extension Service	$86,199 92	$87,124 65	−$924 73

Miscellaneous:			
Short Courses:	Appropriation.	Current Year.	Balances.
Agricultural Economics	$585 00	$560 08	$24 92
Agronomy	4,575 26	4,527 61	47 65
Animal Husbandry	3,460 00	3,445 16	14 84
Dairying	7,395 00	7,393 43	1 57
Entomology	100 00	107 76	−7 76
Farm Management	1,430 00	1,411 83	18 17
Floriculture	2,972 82	2,958 53	14 29
Forestry	25 00	–	25 00
General Horticulture	3,583 45	3,487 61	95 84
Home Economics	1,360 00	1,418 08	−58 08
Horticultural Mfg.	500 61	578 33	−77 72
Library	100 00	48 69	51 31
Microbiology	50 00	47 68	2 32
Office	23,300 64	23,056 06	244 58
Physical Education	1,895 00	1,890 81	4 19
Pomology	8,134 23	7,823 35	310 88
Poultry	2,475 00	2,475 00	–
Rural Engineering	5,941 76	5,935 39	6 37
Treasurer's Office	150 00	156 94	−6 94
Vegetable Gardening	1,981 51	1,964 23	17 28
Salary Surplus	3,241 46	–	3,241 46
Total Short Courses	$73,256 74	$69,286 57	$3,970 17
Market-Garden Field Station	$11,506 38	$11,524 38	−$18 00
Trustees Expenses	1,304 28	1,250 93	53 35
Printing Reports	2,904 70	1,667 44	1,237 26
Total Miscellaneous	$912,995 71	$871,920 75	$41,074 96

Special Appropriations.

	Appropriation.	Expenditure to Date.	Balances.
1922 Chemistry Laboratory	$5,614 22	$5,614 22	
1924 Roads and Walks	260 83	260 83	
1924 Rural Engineering	2,821 70	2,821 70	
1924 Emergency Needs	5,000 00	5,000 00	
1924 Market-Garden Field Station	23,004 36	23,004 31	$0 05
1925 Roads and Walks	1,000 00	1,000 00	
1925 Fencing Fruit Plantation	3,000 00	3,000 00	
1925 Emergency Fund	5,000 00	930 64	4,069 36
1925 Livestock Replacement	4,000 00	2,195 16	1,804 84
Total Special Appropriations	$49,701 11	$43,826 86	$5,874 25

College Buildings (Estimated Value, 1925).

	Inventory at Beginning of Year.	Per Cent deducted.	Value at Beginning of Year less Deterioration.	Repairs and Improvements during Year.	Total Value at Close of Fiscal Year.
Adams Hall	$123,792 64	2	$121,316 79	$1,267 68	$122,584 47
Apiary	2,856 19	2	2,799 07	57 11	2,856 18
Cashier's House	2,285 16	5	2,170 90	157 52	2,328 42
Chemistry Store House	48 56	2	47 59	–	47 59
Clark Hall	59,166 37	2	57,983 04	929 91	58,912 95
Cold Storage Laboratory	9,970 80	2	9,771 38	15 39	9,786 77
Dairy Barn and Storage	28,930 43	3	28,062 52	906 20	28,968 72
Draper Hall	73,431 50	3	71,228 55	2,926 24	74,154 79
Drill Hall and Gun Shed	8,955 89	5	8,508 10	229 31	8,737 41
Durfee Glass House, old	6,957 56	5	6,609 68	135 56	6,745 24
Durfee Glass House, new	9,790 89	5	9,301 35	398 70	9,700 05
Farm Blacksmith Shop	405 59	3	393 42	–	393 42
Farm Bungalow No. 1	2,444 80	3	2,371 46	67 88	2,439 34
Farm Bungalow No. 2	4,265 16	3	4,137 21	84 65	4,221 86
Farm Bungalow No. 3	4,207 93	3	4,081 69	09	4,081 78
Farm House No. 1	3,276 90	3	3,178 59	29 76	3,208 35
Farm Bull Pens and Fence	4,370 71	5	4,152 17	19 68	4,171 85
Fernald Hall	69,132 51	2	67,749 86	500 78	68,250 64
Flint Laboratory	71,045 79	2	69,624 87	448 99	70,073 86
French Hall	45,559 66	2	44,648 47	708 83	45,357 30
Goessmann Laboratory	288,299 00	2	282,533 02	1,060 54	283,593 56
Grinnell Arena	8,546 68	2	8,375 75	19 68	8,395 43
Ground Tool Shed	180 09	5	171 09	–	171 09
Harlow House	2,001 84	5	1,901 75	19 84	1,921 59
Horse Barn	4,510 52	3	4,375 20	90 59	4,465 79
Head of Division of Horticulture	3,086 15	5	2,931 84	21 02	2,952 86
Horticultural Barn	3,744 68	3	3,632 34	150 44	3,782 78
Horticultural Garage	1,488 04	3	1,443 40	–	1,443 40
Horticultural Tool Shed	5,148 72	3	4,994 26	8 34	5,002 60
Horticultural Open Shed	423 59	5	401 41	–	401 41
Horticultural Manufactures Shed	3,107 81	5	2,952 42	–	2,952 42
Hospital	15,801 64	2	15,485 61	216 95	15,702 56
Jewett House and Barn	3,237 56	5	3,075 68	10 48	3,086 16
Machinery Barn	3,241 93	3	3,144 67	245 08	3,389 75
Market Garden Field Station Greenhouse	–	–	–	–	14,000 00
Market Garden Field Station Office and Laboratory Building	–	–	–	–	8,000.00
Market Garden Field Station Farmhouse	6,000 00	5	5,700 00	–	5,700 00
Market Garden Field Station Ice House	100 00	5	95 00	–	95 00
Market Garden Field station Large Cow Barn	9,000 00	5	8,550 00	–	8,550 00
Market Garden Field Station Small Stock Barn	2,000 00	5	1,900 00	–	1,900 00
Market Garden Field station small shed	800 00	5	760 00	–	760 00
Mathematical Building	4,229 23	5	4,017 77	786 65	4,804 42
Memorial Hall	100,268 16	2	98,262 80	455 88	98,718 68
Microbiology Building	54,771 74	2	53,676 31	776 42	54,452 73
Military storage	183 77	5	174 58	–	174 58
Mount Toby House and Barn	3,232 50	5	3,070 87	55 33	3,126 20
North Dormitory	27,892 30	2	27,334 45	1,661 65	28,996 10
Paige Laboratory and Stable	23,388 45	2	22,920 68	222 42	23,143 10
Physics Laboratory	4,451 71	5	4,229 12	409 68	4,638 80
Piggery	2,717 83	3	2,636 30	5 58	2,641 88
Poultry departments:					
No. 1, Demonstration Building	2,003 74	2	1,963 67	4 86	1,968 53
No. 2. Oil House	136 52	2	133 79	16 58	150 37
No. 3. Brooder, killing and fattening laboratory	2,231 30	2	2,186 67	17 49	2,204 16
No. 4. Mechanics, storage building and incubator cellar	4,066 60	2	3,985 27	10 62	3,995 89
No. 5. Laying house	1,715 27	2	1,680 96	–	1,680 96
No. 6. Manure shed	135 40	2	132 69	–	132 69
No. 7. Small Henhouse	42 13	2	41 29	–	41 29
No. 8. Breeding House	1,434 31	2	1,405 62	–	1,405 62
No. 9. Experimental Breeding House	619 55	2	607 16	–	607 16
No. 10. Duck House	87 49	2	85 74	–	85 74
No. 11. Unit house for 200 hens	439 25	2	430 46	–	430 46
No. 12. Unit house for 100 hens	400 70	2	392 69	–	392 69

College Buildings (Estimated Value, 1925) — Concluded.

	Inventory at Beginning of Year.	Per Cent deducted.	Value at Beginning of Year less Deterioration.	Repairs and Improvements during Year.	Total Value at Close of Fiscal Year.
Power Plant and storage buildings including Coal Pocket	$48,902 02	2	$47,923 98	$384 44	$48,308 42
President's House	13,559 15	3	13,152 38	439 46	13,591 84
Rural Engineering Building	14,760 92	2	14,465 70	35 80	14,501 50
Sheep Barn	1,523 68	3	1,477 97	11 57	1,489 54
South Dormitory	41,567 16	2	40,735 82	1,491 44	42,227 26
Stockbridge Hall	159,626 96	2	156,434 42	1,198 52	157,632 94
Agronomy Greenhouse and storage	4,702 24	2	4,608 20	54 23	4,662 43
Stockbridge House	2,152 29	5	2,044 68	10 78	2,055 46
Stone Chapel	29,287 12	2	28,701 38	206 36	28,907 74
Turbine House	17,351 96	2	17,004 92	9 00	17,013 92
Vegetable Plant House	5,261 26	5	4,998 20	21 49	5,019 69
Waiting Station	539 45	2	528 66	5 38	534 04
Wilder Hall	32,018 80	2	31,378 42	101 72	31,480 14
Young stock Barns	6,396 65	3	6,204 75	71 45	6,276 20
Totals	$1,503,710 90	–	$1,469,588 52	$19,192 04	$1,511,314 60

Experiment Station Buildings (Estimated Value).

	Inventory at Beginning of Year.	Per Cent deducted.	Cost at Beginning of Year less Per Cent Deterioration.	Repairs and Improvements during Year.	Total Value at Close of Year.
Agricultural laboratory	$14,119 92	2	$13,837 52	$226 65	$14,064 17
Agricultural barn	4,893 88	3	4,747 06	104 66	4,851 72
Agricultural farmhouse	1,888 20	3	1,831 55	20 21	1,851 76
Agricultural glasshouse	1,087 09	5	1,032 74	18 59	1,051 33
Brooks house	2,895 75	5	2,750 96	21 63	2,772 59
Brooks barn and sheds	1,353 75	5	1,286 06	2 63	1,288 69
Brooks tobacco barn	3,000 00	5	2,850 00	–	2,850 00
Cranberry buildings	2,640 88	5	2,508 84	–	2,508 84
Entomological glasshouses	555 76	5	527 97	–	527 97
Plant and Animal Chemistry laboratory	26,848 75	2	26,311 77	455 48	26,767 25
Plant and Animal Chemistry barns	5,934 66	3	5,756 62	386 44	6,143 06
Plant and Animal dairy	1,757 98	3	1,705 24	–	1,705 24
Six Poultry houses	688 75	2	674 97	–	674 97
Tillson house	948 83	5	901 39	151 08	1,052 47
Tillson barn	1,043 60	5	991 42	–	991 42
Tillson poultry houses (4), Nos. 2, 3, 4, 5	2,894 96	2	2,837 06	–	2,837 06
Tillson incubator cellar No. 1	706 18	2	692 06	–	692 06
Tillson summer sheds (3) No. 6	440 12	5	418 11	–	418 11
Tillson pullet brooder No. 7	1,121 92	5	1,065 82	–	1,065 82
Tillson hen brooder No. 8	1,168 47	5	1,110 05	2 93	1,112 98
	$75,989 45	–	$73,837 21	$1,390 30	$75,227 51

College Equipment (Estimated Value).

Administrative division:	
Dean's Office	$1,258 50
President's Office	2,703 00
Registrar's Office	1,119 87
Treasurer's Office	5,650 60
Agricultural division:	
Agronomy	8,864 50
Animal Husbandry	1,095 81
Dairy	25,440 97
Farm	23,601 95
Farm Livestock	40,243 00
Farm Management	1,080 58
General Agriculture	2,243 47
Poultry	9,260 96
Rural Engineering	10,102 46

Domestic Science	$4,210 84
Dining Hall	42,470 82
Extension	15,655 37
General Science:	
Apiary	2,360 61
Botanical	26,074 36
Chemistry	30,694 21
Entomology	6,256 38
Mathematics	2,321 40
Microbiology	7,051 50
Physics	8,834 36
Veterinary	13,815 01
Zoölogy and Geology	17,660 80
Graduate School	166 25
Horticultural division:	
Floriculture	32,680 63
Forestry	1,200 49
General Horticulture	8,489 50
Grounds	2,864 32
Horticultural Manufactures	5,563 35
Landscape Gardening	6,745 92
Market-Garden Field Station	3,727 06
Mount Toby Reservation	553 96
Pomology	7,319 30
Vegetable Garden	4,010 30
Hospital	948 05
Humanities Division:	
Economics and Sociology	45 50
Language and Literature	740 00
Library	144,408 05
Military	1,987 73
Operating and Maintenance:	
College Supply	931 34
Fire Apparatus	1,640 00
General Maintenance:	
Office	777 70
Carpentry and Masonry Supplies	4,240 90
Carpentry and Masonry Tools	5,273 07
Electrical Supplies	2,759 79
Electrical Tools	237 89
Electrical Commencement Supplies	619 75
Heating and Plumbing Supplies	8,291 23
Heating and Plumbing Tools	2,569 82
Painting Supplies	1,336 25
Painting Tools	295 88
Steam Main	5,089 57
Lighting Lines	9,817 22
Janitor's Supplies	1,364 61
Sewer Line	13,480 77
Water Mains	13,439 24
Power Plant:	
General Equipment	97,473 38
Tools	296 80
Supplies	234 30
Fuel	2,883 65
Physical Education	1,823 74
Rural Social Science:	
Agricultural Economics	2,155 45
Agricultural Education	1,746 96
Rural Sociology	220 04
Short Course	3,033 95

Textbooks	$3,640 50
Trophy Room	733 20
Women's Dormitory	10,359 31
Memorial Hall	14,822 00
Freshman Agriculture	223 85
Total	$743,333 90

Experiment Station Equipment (Estimated Value).

Agronomy	$382 43
Apiary	142 11
Agricultural Economics Department	515 70
Agricultural Laboratory	11,123 46
Botany	8,634 15
Cranberry Station	13,243 08
Director's Office	4,939 00
Entomological laboratory	24,632 29
Entomology at Market-Garden Field Station	258 57
Fertilizer and Feed Control	14,735 03
P and A Chemistry	18,098 68
Meteorological Observatory	635 00
Microbiological laboratory	4,088 80
Pomology	4,810 99
Poultry Department	5,931 80
Treasurer's Office	983 61
Veterinary	2,527 75
	$115,682 45

Inventory — Real Estate.

Land (Estimated Value).

Angus Land	$800 00
Allen Place	500 00
Baker Place	2,500 00
Bangs Place	2,350 00
Brooks Farm	11,000 00
Brown Land	500 00
Charmbury Place	450 00
Clark Place	4,500 00
College Farm	37,000 00
Cranberry Land	12,745 00
George Cutler Jr., Trustee	2,700 00
Dickinson Land	7,850 00
Harlow Farm and Orchard	3,284 63
Hawley and Brown Place	675 00
Kellogg Place	3,368 45
Loomis Place	415 00
Louisa Baker Place	5,000 00
Market-Garden Field Station	21,000 00
Mount Toby demonstration forest	30,000 00
Newell Farm	2,800 00
Old Creamery Place	1,000 00
Owen Farm	5,000 00
Pelham Quarry	500 00
Tillson Farm	2,950 00
Westcott Place	2,250 00
	$161,138 08

Summary.

Land	$161,138 08
College buildings	1,511,314 60
College equipment	743,333 90
Experiment Station buildings	75,227 51
Experiment Station equipment	115,682 45
Total	$2,606,696 54

	Acres.
College estate (area)	702.19
Cranberry Station, Wareham (area)	23.67
Market-Garden Field Station, Waltham (area)	55.39
Mount Toby demonstration forest (area)	755.27
Rifle range	46.20
Pelham quarry	.50
Total acreage	1,583.22

Dining Hall Statement November 30, 1925.

Balance December 1, 1924	$9,911 07	
Total Disbursements	127,017 04	
Outstanding Bills November 30, 1925	3,861 43	
Total Collections		$123,786 55
Outstanding Accounts:		
Board		1,393 58
Special Service		336 58
Inventory November 30, 1925		12,461 95
Balance		2,810 88
	$140,789 54	$140,789 54

Burnham Emergency Fund.

	Market Value Dec. 1, 1925.	Par Value.	Income.
Two bonds American Telephone and Telegraph Company 4s at $97	$1,940 00	$2,000 00	$60 00
Two bonds Power Corporation of N. Y. 6½s at $104	2,080 00	2,000 00	130 00
One United States Liberty Bond 4½s $102	510 00	500 00	21 25
One bond Ohio Service Company 6s $100	500 00	500 00	30 00
	$5,030 00	$5,000 00	$261 25
Unexpended balance December 1, 1924	–	–	322 40
	–	–	$583 65
Disbursements for fiscal year ending November 30, 1925	–	–	331 25
Cash on hand November 30, 1925	–	–	$252 40

Library Fund.

Five bonds New York Central & Hudson River Railroad Company 4s at $94	$4,700 00	$5,000 00	$200 00
Five bonds Lake Shore and Michigan Southern Railroad Co., 4s at $98	4,900 00	5,000 00	200 00
Two shares New York Central Railroad Stock at $128	256 00	200 00	14 00
Amherst Savings Bank deposit	175 52	175 52	7 77
	$10,031 52	$10,375 52	$421 77
Winchester store	–	–	2 95
	–	–	$424 72
Disbursements for fiscal year ending November 30, 1925	–	–	424 72

Special Funds.

Endowed Labor Fund (the Gift of a Friend of the College).

	Market Value Dec. 1, 1925.	Par Value.	Income.
Two bonds American Telephone and Telegraph Company 4s at $97	$1,940 00	$2,000 00	$80 00
Two bonds Lake Shore & Michigan Southern Railroad Co., 4s at $98	1,960 00	2,000 00	80 00
One bond New York Central Railroad Gold debenture 4s	1,280 00	1,000 00	40 00
One bond Ohio Service Company 6s	1,000 00	1,000 00	60 00
Amherst Savings Bank deposit	1,143 39	1,143 39	25 24
One bond Indiana Hydro Electric Co. 6s	990 00	1,000 00	60 00
	$8,313 39	$8,143 39	$345 24
Unexpended balance December 1, 1924	–	–	982 22
	–	–	$1,327 46
Disbursements for fiscal year ending November 30, 1925	–	–	1,201 25
Cash on hand November 30, 1925	–	–	$126 21

Whiting Street Scholarship Fund.

One bond New York Central & Hudson Railroad Gold Debenture 4s	$940 00	$1,000 00	$40 00
Amherst Savings Bank deposit	771 64	771 64	21 69
	$1,711 64	$1,771 64	$61 69
Unexpended balance Dec. 1, 1924	–	–	660 29
	–	–	$721 98
Disbursements for fiscal year ending November 30, 1925	–	–	500 00
Cash on hand November 30, 1925	–	–	$221 98

Hills Fund.

One United States Liberty Bond 4¼s	$1,020 00	$1,000 00	$42 50
One bond American Telephone and Telegraph Company 4s	970 00	1,000 00	40 00
One bond New York Central & Hudson River Railroad debenture 4s	940 00	1,000 00	40 00
One bond New York Central Railroad debenture 4s	1,280 00	1,000 00	40 00
Three bonds Pacific Telephone and Telegraph Company 5s at $101	3,030 00	3,000 00	150 00
One Penn. Public Service Corporation 6s	1,000 00	1,000 00	60 00
Boston & Albany Railroad stock 3⅝ shares at $160	580 00	362 00	31 68
Amherst Savings Bank deposit	2,572 75	2,572 75	50 16
Electric Securities Company bonds 1 9/50 bonds at $94	1,109 20	1,180 00	59 00
One bond Great Western Light & Power Company 5½s	1,000 00	1,000 00	–
One bond American Gas & Electric Co. 6s	980 00	1,000 00	–
One bond Potomac Edison Company 6½s	1,030 00	1,000 00	$65 00
	$15,511 95	$15,114 75	$578 34
Unexpended balance December 1, 1924	–	–	2,618 88
Great Western Light and Power Co. 6s	–	–	120 00
Earnings from exchange of bonds	–	–	27 50
	–	–	$3,344 72
Disbursements for fiscal year ending November 30, 1925	–	–	2,885 56
Cash on hand November 30, 1925	–	–	$459 16

Mary Robinson Fund.

Amherst Savings Bank deposit	$142 00	$142 00	$6 45
Boston & Albany R.R. Stock 3/8 share at $160	60 00	38 00	3 32
Electric Securities Co. 41/50 bond at $94	770 80	820 00	41 00
	$972 80	$1,000 00	$50 77
Unexpended balance December 1, 1924	–	–	241 15
Cash on hand November 30, 1925	–	–	$291 92

Grinnell Prize Fund.

Ten shares New York Central stock at $128	$1,280 00	$1,000 00	$70 00
Unexpended balance December 1, 1924	–	–	302 64
	$1,280 00	$1,000 00	$372 64
Disbursements for Prizes	–	–	50 00
Cash on hand November 30, 1925	–	–	$322 64

Gassett Scholarship.

	Market Value Dec. 1, 1925.	Par Value.	Income.
One bond New York Central & Hudson River Railroad debenture 4s	$940 00	$1,000 00	$40 00
Amherst Savings Bank deposit	511 64	511 64	9 85
	$1,451 64	$1,511 64	$49 85
Unexpended balance December 1, 1924	–	–	506 74
	–	–	$556 59
Disbursements for fiscal year ending November 30, 1925	–	–	500 00
Cash on hand November 30, 1925	–	–	$56 59

Massachusetts Agricultural College (Investment).

One share New York Central Railroad stock $128	$1,280 00	$100 00	$7 00
Unexpended balance December 1, 1924	–	–	126 14
Cash on hand November 30, 1925	$1,280 00	$100 00	$133 14

Danforth Keyes Bangs Fund.

Two bonds Pacific Telephone and Telegraph Company 5s at $101	$2,020 00	$2,000 00	$100 00
Two bonds Union Electric Light & Power Company 5s at $100	2,000 00	2,000 00	100 00
Two bonds American Telephone and Telegraph Company 4s at $97	1,940 00	2,000 00	80 00
One bond Indiana Hydro-Electric Power Company 6s	990 00	1,000 00	30 00
Interest from Student Loans	–	–	130 60
	$6,950 00	$7,000 00	$440 60
Unexpended balance December 1, 1924	–	–	2,219 34
Oklahoma Gas & Electric Co.	–	–	30 00
Earnings from exchange of bonds	–	–	23 93
	–	–	$2,713 87
Total loans made to students during fiscal year, $3,933.75	–	–	–
Cash received on account of student loans, $2,959.50	–	–	–
Excess of loans made over accounts paid by students	–	–	974 25
Cash on hand November 30, 1925	–	–	$1,739 62

John C. Cutter Fund.

One bond Pacific Telephone and Telegraph Company 5s	$1,010 00	$1,000 00	$50 00
Unexpended balance December 1, 1924	–	–	91 34
	$1,010 00	$1,000 00	$141 34
Disbursements for fiscal year ending November 30, 1925	–	–	23 98
Cash on hand November 30, 1925	–	–	$117 36

William R. Sessions Fund.

Five shares New York Central Railroad stock at $128	$640 00	$500 00	$26 25
Three United States Liberty bonds, two at $1,000; one at $500, 4¼s at $102	2,550 00	2,500 00	106 25
One bond Adirondack Light & Power Company 6s	1,040 00	1,000 00	60 00
One bond Southern Illinois Light & Power Company 6s	1,020 00	1,000 00	60 00
	$5,250 00	$5,000 00	$252 50
Unexpended balance December 1, 1924	–	–	158 84
	–	–	$411 34
Disbursements for fiscal year ending November 30, 1925	–	–	339 93
Cash on hand November 30, 1925	–	–	$71 41

Alvord Dairy Scholarship Fund.

One United States Liberty Bond 4¼s	$1,020 00	$1,000 00	$42 50
One bond Southern Illinois Light & Power Company 7s	1,030 00	1,000 00	70 00
Two bonds Great Western Power Company 5½s at $100	2,000 00	2,000 00	–
Amherst Savings Bank deposit	1,000 00	1,000 00	18 75
	$5,050 00	$5,000 00	$131 25
Unexpended balance December 1, 1924	–	–	1,095 11
Great Western Power Company 6s	–	–	120 00
Earnings from exchange of bonds	–	–	20 00
	–	–	$1,366 36
Disbursement for fiscal year ending November 30, 1925	–	–	1,152 00
Cash on hand November 30, 1925	–	–	$214 36

J. D. W. French Fund.

	Market Value Dec. 1, 1925.	Par Value.	Income.
Two bonds Southern Illinois Light & Power Company 6s at $102	$2,040 00	$2,000 00	$120 00
Two bonds Great Western Light & Power Company 5½s at $100	2,000 00	2,000 00	–
Four bonds Penn. Public Service corporation, two 6½s at $103, two 6s at $100	4,060 00	4,000 00	250 00
Two bonds Ohio Service Company 6s at $100	2,000 00	2,000 00	120 00
Amherst Savings Bank	500 00	500 00	9 38
	$10,600 00	$10,500 00	$499 38
Unexpended balance December 1, 1924	–	–	926 12
Great Western Light & Power Company 6s	–	–	120 00
Earnings from exchange of bonds	–	–	20 00
	–	–	$1,565 50
Disbursements for fiscal year ending November 30, 1925	–	–	1,267 58
Cash on hand November 30, 1925	–	–	$297 92

Students' Loan Fund of the Massachusetts Agricultural Club.

First National Bank	$500 00	$500 00	–
Total loans to students	–	500 00	–
	–	–	–
Interest from loans	–	–	$16 36
Cash on hand November 30, 1925	–	–	$16 36

F. G. Crane Fund.

Five bonds Ohio Service Company 6s at $100		$5,000 00	$5,000 00	$300 00
Two bonds Power Corporation of New York 6½s at $104		2,080 00	2,000 00	130 00
Four bonds Potomac Edison Company 6½s at $103		4,120 00	4,000 00	260 00
Four bonds Northern New York Utilities 6s at $101		4,040 00	4,000 00	240 00
Five bonds Penn. Public Service Corporation 6½s at $103		5,150 00	5,000 00	325 00
Five bonds Illinois Power & Light Corporation 6s at $101		5,050 00	5,000 00	300 00
Amherst Savings Bank		250 00	250 00	11 35
		$25,690 00	$25,250 00	$1,566 35
Unexpended balance December 1, 1924		–	–	615 57
Interest on loans	$0 63	–	–	–
Cash received on loans	50 00	–	–	–
		–	–	50 63
		–	–	$2,232 55
Scholarship to students Cash	$1,025 00	–	–	–
Loans	50 00	–	–	–
		–	–	1,075 00
Cash on hand November 30, 1925		–	–	$1,157 55

Summary of Balance on Hand of the Income from Funds Held in Trust by the M. A. C.

Burnham Emergency Fund	$252 40
Endowed Labor Fund	126 21
Whiting Street Scholarship Fund	221 98
Hills Fund	459 16
Mary Robinson Fund	291 92
Grinnell Prize Fund	322 64
Gassett Scholarship	56 59
Massachusetts Agricultural College Investment Fund	133 14
Danforth Keyes Bangs Fund	1,739 62
John C. Cutter Fund	117 36
Alvord Dairy Scholarship Fund	214 36
J. D. W. French Fund	297 92
Massachusetts Agricultural Club Fund	16 36
William R. Sessions Fund	71 41
F. G. Crane Fund	1,157 55
	$5,478 62

HISTORY OF SPECIAL FUNDS.

Burnham Emergency Fund. — A bequest of $5,000 from T. O. H. P. Burnham of Boston made without any conditions. The Trustees of the College have used this fund in any cases of emergency where funds were not available. At present the fund is intact and the income only has been used for such emergency matters as the Trustees have authorized. The fund now shows an investment of $5,000.00.

Library Fund. — The library of the college at the present time contains 75,066 volumes. The income from the fund raised by the alumni and others is devoted to its increase, and additions are made from time to time as the needs of the different departments require. Dec. 27, 1883, William Knowlton gave $2,000; Jan. 1, 1894, Charles L. Flint gave $1,000; in 1887, Elizur Smith of Lee, Mass., gave $1,315. These were the largest bequests and now amount to $10,375.52.

Endowed Labor Fund. — Gift of a friend of the college in 1901, income of which is to be used for the assistance of needy and deserving students, $5,000.00.

Whiting Street Scholarship Fund. — Gift of Whiting Street of Northampton, for no special purpose, but to be invested and the income used. This fund is now used exclusively for scholarship, $1,000.00.

Hills Fund. — Gift of Leonard M. and Henry F. Hills of Amherst, Mass., in 1867, to establish and maintain a botanic garden, $10,000.00.

Mary Robinson Fund. — Gift of Miss Mary Robinson of Medfield, in 1874, for scholarship, $1,000.00.

Grinnell Prize Fund. — Gift of Hon. Wm. Claflin, to be known as the Grinnell agricultural prize, to be given to the two members of the graduating class who may pass the best oral and written examination in theory and practice of agriculture, given in honor of George B. Grinnell of New York, $1,000.00.

Gassett Scholarship Fund. — Gift of Henry Gassett of Boston, the income to be used for scholarship, $1,000.00.

Massachusetts Agricultural College Investment Fund. — Investment made by vote of trustees in 1893 to purchase one share of New York Central & Hudson River Railroad stock. The income from this fund has been allowed to accumulate, $100.00.

Danforth Keyes Bangs Fund. — Gift of Louisa A. Baker of Amherst, Mass., April 14, 1909, the income thereof to be used annually in aiding poor, industrious, and deserving students to obtain an education in said college, $6,000.00.

John C. Cutter Fund. — Gift of Dr. John C. Cutter of Worcester, Mass., an alumnus of the college, who died in August, 1909, to be invested by the trustees, and the income to be annually used for the purchase of books on hygiene, $1,000.00.

Alvord Dairy Scholarship Fund. — Gift of Henry E. Alvord, who was the first instructor in military tactics, 1869–71, and a professor of agriculture, 1885–87, at this institution. The income of this fund is to be applied to the support of any worthy student of said college, graduate or postgraduate, who may be making a specialty of the study of dairy husbandry (broadly considered) with the intention of becoming an investigator teacher or special practitioner in connection with the dairy industry, provided that no benefits arising from such fund shall at any time be applied to any person who then uses tobacco in any form, or fermented or spirituous beverages, or is known to have done so within one year next preceding, $4,000.00.

William R. Sessions Fund. — In accordance with the request of my deceased wife, Clara Markham Sessions, made in her last will, I bequeath to the trustees of the Massachusetts Agricultural College, Amherst, Mass., the sum of $5,000, it being the amount received by me from the estate of the said Clara Markham Sessions. The said $5,000 to be kept by the said trustees a perpetual fund, the income from which shall be for the use of the Massachusetts Agricultural College; and according to the further request of my deceased wife, made in her last will, this is to be known as the William R. Sessions fund, and is to be a memorial of William R. Sessions; and it is my special request that the said trustees shall make record of the fact that this fund came from the estate of my deceased wife Clara Markham Sessions, in accordance with her request made in her last will, $5,000.00.

J. D. W. French Fund. — Gift of the Bay State Agricultural Society of Boston Mass. This fund to be known as the J. D. W. French Fund, and the Trustees of the Massachusetts Agricultural College are to use the income of this fund where it will do the greatest good, in the interest of Dairying and its allies, also in Forestry, as scholarships, loans, or prizes; especially, however, to help pay the expenses of the judging teams to the National Dairy Show and to the National Livestock Show, $10,000.00.

Frederick G. Crane Fund. — Gift of Frederick G. Crane of Dalton, Massachusetts. The income of this fund is to be expended by the Trustees of the Massachusetts Agricultural College in aid of worthy undergraduate students of limited financial resources at the college, preference being given to residents of Berkshire County; such payments are to be known as the Frederick G. Crane Scholarships, $25,000.00.

Massachusetts Agricultural College Fund. — The Massachusetts Agricultural Club gave $500 to be used as a scholarship fund to the Massachusetts Agricultural College to help out deserving students there, who intended seriously to go into agriculture, interest on loans not to be charged until after graduation, $500.00.

Total of special funds, $85,975.52.

FRED C. KENNEY,
Treasurer.

PUBLIC DOCUMENT No. 31

THE M. A. C. BULLETIN

AMHERST, MASSACHUSETTS

VOLUME XVIII JANUARY, 1926 NUMBER I

PUBLISHED EIGHT TIMES A YEAR BY THE MASSACHUSETTS AGRICULTURAL COLLEGE: JAN., FEB., MARCH, MAY, JUNE, SEPT., OCT., NOV. ENTERED AT THE POST OFFICE, AMHERST, MASS., AS SECOND CLASS MATTER

THE SIXTY-THIRD ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

PART II. — CATALOGUE OF THE COLLEGE FOR 1925–1926

Publication of this Document approved by the Commission on Administration and Finance

6 M-8-'25. No. 2426.

The Commonwealth of Massachusetts

MASSACHUSETTS AGRICULTURAL COLLEGE,
AMHERST, November 30, 1925.

To the Commissioner of Education.

SIR: — On behalf of the trustees of the Massachusetts Agricultural College I have the honor to transmit herewith Part II of the sixty-third annual report of the trustees for the fiscal year ended November 30, 1925, this being the catalogue of the college.

Respectfully yours,

EDWARD M. LEWIS,
Acting President.

CONTENTS.

Without excluding other scientific and classical studies, and including military tactics, to teach such branches of learning as are related to agriculture and mechanic arts in such manner as the legislatures of the states may respectively prescribe, in order to promote the liberal and practical education of the industrial classes in the several pursuits and professions of life. — *Act of Congress, July 2, 1862.*

This issue of the catalogue represents the status of the college for the current college year, with provisional announcement of courses of study and other matters for the year to follow. When deemed necessary, additional announcements are made in a supplementary bulletin, published in the spring.

The college reserves, for itself and its departments, the right to withdraw or change the announcements made in its catalogue.

Calendar.

1925–1926.

1925.

September 14, Monday	Fall term begins for Freshmen
September 16, Wednesday	Fall term begins for all except Freshmen; Assembly 1.30 P.M.
October 12, Monday	Holiday — Columbus Day
November 25–30, Wednesday, 12 M.–Monday, 7.30 A.M.	Thanksgiving Recess
December 19, Saturday, 12 M.	Fall Term Ends

1926.

January 4, Monday, 7.30 A.M.	Winter term begins
February 22, Monday	Holiday, Washington's Birthday
March 20, Saturday, 12 M.	Winter term ends.
March 29, Monday, 7.30 A.M.	Spring term begins
April 19, Monday	Holiday, Patriot's Day
May 31, Monday	Holiday, Observance of Memorial Day
June 11–14, Friday–Monday	Commencement
June 17–19, Thursday–Saturday	Entrance Examinations
September 8–11, Wednesday–Saturday	Entrance Examinations
September 13, Monday	Fall term begins for Freshmen
September 15, Wednesday	Fall term begins for all except Freshmen
October 12, Tuesday	Holiday, Columbus Day
November 24–29, Wednesday, 12 M.–Monday, 7.30 A.M.	Thanksgiving Recess
December 18, Saturday, 12 M.	Fall term ends

1927.

January 3, Monday, 7.30 A.M.	Winter term begins

Massachusetts Agricultural College.

History. — The Massachusetts Agricultural College was organized under the national land grant act of 1862. This legislation is also known as the Morrill act, the original bill having been framed by Justin Smith Morrill, Senator from Vermont, and its final enactment secured under his leadership. It provided that public lands be assigned to the several States and territories, the funds from the sale of which were to be used to establish and maintain colleges of agriculture and mechanic arts. The Massachusetts Agricultural College was among the first of these institutions established. When this act was passed the Massachusetts Institute of Technology was already organized, and the State of Massachusetts decided that the instruction in the mechanic arts should be at the Institute, and that the new institution should confine its work to agriculture. On this account the Massachusetts Agricultural College has the unique distinction of being the only separate agricultural college in the country.

In 1863 the State of Massachusetts accepted the provisions of the Morrill act and incorporated the Agricultural College. The location at Amherst was selected only after long and careful study by the original Board of Trustees. The college was formally opened to students on the 2d of October, 1867, with a faculty of four teachers and with four wooden buildings.

The Massachusetts Legislature has granted money for the erection of practically all of the buildings now on the grounds. In view of the fact that the annual income from the original endowment has been only a few thousand dollars, it has been necessary for the State to assume large responsibility for the current expenses of the institution.

Organization. — The college is a State institution, serving in the Department of Education and as such is subject to the laws governing and the rules applying to all State departments and institutions. The work of the college is directed by a board of eighteen trustees. Four of these are ex-officio members, — the Governor of the State, the Commissioner of Education, the Commissioner of Agriculture and the President of the college. The other fourteen members are appointed by the Governor, two each year, for terms of seven years. The immediate control of the institution is vested in the President of the college. The administrative officers, having supervision of the various departments of activity, are directly responsible to the President.

In carrying out its purpose the college has organized three distinct yet correlated types of work, — namely, research, resident instruction and extension service.

Research. — In 1882 Massachusetts provided for the establishment of an agricultural experiment station. This station, though on the college grounds and supported by the State, was without organic connection with the college. Under an act of Congress, passed in 1887, an agricultural experiment station was established and supported as a department of the college. For a time, therefore, Massachusetts had two experiment stations at the college. In 1895 these were combined, and the station reorganized as a department of the college. It is now supported by funds from both the State and the Federal government. In 1906 the Federal government largely increased its support on condition that the money thus provided should be used only for research. The station now receives about two-thirds of its support from the State.

The station is under the direct supervision of the Board of Trustees; the chief officer is the director, who is responsible to the President. It is organized into a number of departments, all co-operating toward the betterment of agriculture. In most cases the heads of these departments are heads of corresponding departments in the college.

Resident Instruction. — The college offers an education without tuition fee to any student who is a resident of Massachusetts and who meets the requirements for admission. Women are admitted on the same basis as are men. Students who are not residents of Massachusetts are required to pay a tuition fee. The chief aim of the institution, through its resident instruction, is to prepare men and women for the agricultural vocations. The term "agricultural vocations" is here used in its broadest sense. Courses are offered which give efficient training in various agricultural pursuits, such as general farming, dairying, management of estates, poultry husbandry, fruit growing, market gardening, floriculture, landscape gardening and forestry. Students are also trained for investigation in many sciences underlying the great agricultural industry, for teaching in agricultural colleges and high schools, and for scientific work in chemistry, entomology, botany and microbiology. Comprehensive courses in home making are now available for women.

Though training for the agricultural vocations is thus the chief concern of the college, students should find the course one that trains them admirably for pursuits in which the sciences are an essential preparation. The course of study aims also to combine an adequate general education with specialized technical and practical training.

Four-year Courses. — Twenty-nine teaching departments offer instruction in agriculture, horticulture, sciences, the humanities, rural social science and home making. A system of major courses permits the student to elect major work in one of sixteen departments, and to specialize in it and allied subjects for a period of two years. The degree of bachelor of science is granted on the satisfactory completion of the four years' work of collegiate grade.

Short Courses. — In order to extend the advantages of the institution to those men and women who cannot or do not care to pursue the four-year course, various short courses are offered. Chief among these are a two-year course in practical agriculture, a summer school of agriculture and country life, and a winter school of agriculture.

Graduate School. — The graduate school is organized to provide the necessary training for scientific leadership in agriculture and allied sciences. The degrees of master of agriculture, master of landscape architecture, master of science, doctor of agriculture and doctor of philosophy may be earned upon the completion of satisfactory study, research and thesis.

The Extension Service. — The Extension Service is the organized educational agency of the college which serves the people of the State other than resident students. Its function is to make available to Massachusetts citizens useful and practical information in agriculture and home economics which is developed by the experiment station or the United States Department of Agriculture, and which is taught by the college to resident students. It is the recognized agency of the United States Department of Agriculture for teaching those who cannot attend college, and is a cooperative effort by the Department of Agriculture, the Massachusetts Agricultural College, and the County Extension Services.

The Extension Service uses many methods of work, among which are the following:

- Demonstrations.
- Publications.
- Correspondence Courses.
- Lectures.
- Exhibits.
- Extension Schools.
- Leader-training Groups.
- Boys' and Girls' Clubs in Agriculture and Home Economics.
- Agricultural News Letters.

Literature descriptive of these various services will be mailed on request. Information may also be secured from the county agricultural agents at the following addresses:

Berkshire County Extension Service, Howard Block, Pittsfield, Mass.
Bristol County Agricultural School, Segreganset, Mass.
Cape Cod Extension Service, Hyannis, Mass.
Essex County Agricultural School, Hathorne, Mass.
Franklin County Extension Service, Sheldon Block, Greenfield, Mass.
Hampden County Improvement League, 244 Main St., Springfield, Mass.
Hampshire County Extension Service, 59 Main St., Northampton, Mass.
Middlesex County Extension Service, 12 Moody St., Waltham, Mass.
Norfolk County Agricultural School, Walpole, Mass.
Plymouth County Extension Service, 106 Main St., Brockton, Mass.
Worcester County Extension Service, 11 Foster St., Worcester, Mass.

Location and Equipment. — The Agricultural College is located in the town of Amherst. The grounds comprise approximately 700 acres, lying about a mile north of the village center. The college has also a demonstration forest of 755 acres, located 6 miles north of the campus. The equipment of the college, both in buildings and facilities for instruction, is excellent. Amherst is 97 miles from Boston, and may be reached by the Central Massachusetts division of the Boston & Maine Railroad, or by the Central Vermont Railroad. Electric car lines connect Amherst with Northampton, Holyoke and Springfield.

Military Drill. — By Federal law military drill is required of all regular students attending the Massachusetts Agricultural College.

The Trustees.

Organization of 1925.

Members of the Board.

	Term Expires
Davis R. Dewey of Cambridge	1926
John F. Gannon of Pittsfield	1926
Arthur G. Pollard of Lowell	1927
George H. Ellis of West Newton	1927
John Chandler of Sterling Junction	1928
Atherton Clark of Newton	1928
Nathaniel I. Bowditch of Framingham	1929
William Wheeler of Concord	1929
Charles A. Gleason[1] of North Brookfield	1930
James F. Bacon of Boston	1930
Frank Gerrett of Greenfield	1931
Harold L. Frost of Arlington	1931
Charles H. Preston of Danvers	1932
Carlton D. Richardson of West Brookfield	1932

Members Ex Officio.

His Excellency Governor Alvan T. Fuller, *President of the Board of Trustees.*
Edward M. Lewis, *Acting President of the College.*
Payson Smith, *State Commissioner of Education.*
Arthur W. Gilbert, *State Commissioner of Agriculture.*

Officers of the Trustees.

His Excellency Governor Alvan T. Fuller of Boston, *President.*
Charles A. Gleason[1] of North Brookfield, *Vice-President.*
Ralph J. Watts of Amherst, *Secretary.*
Fred C. Kenney of Amherst, *Treasurer.*
Charles A. Gleason[1] of North Brookfield, *Auditor.*

Standing Committees of the Trustees.[2]

Committee on Finance.

Charles A. Gleason,[1] *Chairman.*
George H. Ellis.
Nathaniel I. Bowditch.
Arthur G. Pollard.
Carlton D. Richardson.
Atherton Clark.

Committee on Course of Study and Faculty.

William Wheeler, *Chairman.*
James F. Bacon.
Payson Smith.
Davis R. Dewey.
John F. Gannon.
Arthur W. Gilbert.

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[1] Died September 29, 1925.
[2] The President of the College is ex-officio member of each committee.

Committee on Farm.

NATHANIEL I. BOWDITCH, *Chairman*.
FRANK GERRETT.
GEORGE H. ELLIS.
ARTHUR W. GILBERT.
CARLTON D. RICHARDSON.

Committee on Horticulture.

HAROLD L. FROST, *Chairman*.
CHARLES A. GLEASON.[1]
JOHN CHANDLER.
ATHERTON CLARK.
CHARLES H. PRESTON.

Committee on Experiment Department.

CHARLES H. PRESTON, *Chairman*.
ARTHUR W. GILBERT.
JOHN CHANDLER.
ARTHUR G. POLLARD.
HAROLD L. FROST.
CARLTON D. RICHARDSON.

Committee on Buildings and Arrangement of Grounds.

GEORGE H. ELLIS, *Chairman*.
FRANK GERRETT.
WILLIAM WHEELER.
JAMES F. BACON.
CHARLES H. PRESTON.
ATHERTON CLARK.

Committee on Extension Service.

JOHN CHANDLER, *Chairman*.
NATHANIEL I. BOWDITCH.
GEORGE H. ELLIS.
HAROLD L. FROST.
DAVIS R. DEWEY.
JOHN F. GANNON.
ARTHUR W. GILBERT.

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[1] Died September 29, 1925.

Officers of the Institution.

As of Nov. 1, 1925.

Officers of General Administration.

Edward M. Lewis, A.M. . . . . President's House.
Dean and Acting President.

Sidney B. Haskell, B.Sc. . . . . 2 Mount Pleasant.
Director of Experiment Station.

Fred C. Kenney . . . . Mount Pleasant.
Treasurer of the College.

William L. Machmer, A.M. . . . . 25 Amity Street.
Acting Registrar and Acting Dean of the College.

Charles E. Marshall, Ph.D. . . . . 10 South Prospect Street.
Director of the Graduate School.

Richard A. Mellen, B.Sc. . . . . 25 Fearing Street.
Field Agent.

Roland H. Verbeck, B.Sc. . . . . Tyler Place.
Director of Short Courses.

Ralph J. Watts, B.Sc. . . . . 101 Butterfield Terrace.
Secretary of the College.

John D. Willard, M. Sc. . . . . 31 Lincoln Avenue.
Director of the Extension Service.

Basil B. Wood, A.B. . . . . 6 Boltwood Avenue.
Librarian of the College.

The Faculty of Instruction.

Edward M. Lewis, A.M. . . . . President's House.
Dean and Acting President of the College, Professor of Languages and Literature, Head of Department and Head of Division of Humanities.

Max F. Abell, Ph.D. . . . . North Amherst.
Assistant Professor of Farm Management.

George W. Alderman, B.A. . . . . Tillson Court.
Assistant Professor of Physics.

Charles P. Alexander, Ph.D. . . . . 120 Pleasant Street.
Assistant Professor of Entomology.

Luther B. Arrington, B.Sc. . . . . 41 Lincoln Avenue.
Instructor in Horticulture.

Edgar L. Ashley, A.M. . . . . Amherst House.
Professor of French.

Lorin E. Ball, B.Sc. . . . . 3 Allen Street.
Instructor in Physical Education.

Luther Banta, B.Sc. . . . . Sunset Avenue.
Assistant Professor of Poultry Husbandry.

Mary A. Bartley . . . . 12 East Pleasant Street.
Instructor in Home Economics.

Arthur B. Beaumont, Ph.D. . . . . 51 Amity Street.
Professor of Agronomy and Head of Department.

Leon A. Bradley, Ph.D. . . . . North Amherst.
Assistant Professor of Microbiology.

N. Butler Briscoe, Major, Cavalry, U. S. A.
Professor of Military Science and Tactics, and Head of Department.

Frederic R. Butler, Ph.D. . . . . 42 Lincoln Avenue.
Instructor in Chemistry.

Alexander E. Cance, Ph.D. . . . . 9 Fearing Street.
Professor of Agricultural Economics and Head of Department.

Morton H. Cassidy, B.Sc. . . . . The Apiary.
Assistant Professor of Beekeeping.

Joseph S. Chamberlain, Ph.D. . . . . Mount Pleasant.
Professor of Organic and Agricultural Chemistry.

Walter W. Chenoweth, M.Sc. . . . . North Amherst.
Professor of Horticultural Manufactures and Head of Department.

Orton L. Clark, B.Sc. . . . . 12 College Street.
Assistant Professor of Botany.

G. Chester Crampton, Ph.D. . . . . Fernald Hall.
Professor of Insect Morphology.

William H. Davis, Ph.D. . . . . 12 Nutting Avenue.
Assistant Professor of Botany.

Llewellyn L. Derby . . . . Amherst House.
Instructor in Physical Education.

Lawrence S. Dickinson, B.Sc. . . . . 2 Farview Way.
Assistant Professor of Horticulture.

Brooks D. Drain, S.M. . . . . 17 Fearing Street.
Assistant Professor of Pomology.

Henry T. Fernald, Ph.D. . . . . 44 Amity Street.
Professor of Entomology, Head of Department, Chairman of Division of Science.

Mary J. Foley, B.Sc. . . . . 3 South Prospect Street.
Instructor in Agricultural Economics.

James A. Foord, M.Sc.Agr. . . . . 54 Lincoln Avenue.
Professor of Farm Management and Head of Department, Acting Head, Division of Agriculture.

Arthur P. French, M.Sc. . . . . 9 Phillips Street.
Instructor in Pomology.

George E. Gage, Ph.D. . . . . The Davenport.
Professor of Animal Pathology and Head of Department of Veterinary Science and Animal Pathology.

Mary E. M. Garvey, B.Sc. . . . . 29 South Prospect Street.
Instructor in Microbiology.

Guy V. Glatfelter, M.Sc. . . . . 29 Northampton Road.
Assistant Professor of Animal Husbandry.

Harry N. Glick, Ph.D. . . . . 27 Fearing Street.
Professor of Agricultural Education.

Helena T. Goessmann, M.Ph. . . . . 35 South Pleasant Street.
Instructor in English.

Clarence E. Gordon, Ph.D. . . . . 38 Lincoln Avenue.
Professor of Zoölogy and Geology and Head of Department.

Harold M. Gore, B.Sc. . . . . Plainville Road.
Assistant Professor of Physical Education.

John C. Graham, B.Sc.Agr. . . . . 68 Lincoln Avenue.
Professor of Poultry Husbandry and Head of Department.

Laurence R. Grose, A.B., M.F. . . . . 32 Amity Street.
Professor of Forestry and Head of Department.

Christian I. Gunness, B.Sc. . . . . 105 Butterfield Terrace.
Professor of Rural Engineering and Head of Department.

Raymond Halliday, B.A. . . . . The Davenport.
Instructor in French.

Margaret Hamlin, B.A. . . . . 12 North East Street.
Agricultural Counsellor for Women.

Arthur K. Harrison . . . . 8 Allen Street.
Assistant Professor of Landscape Gardening.

Curry S. Hicks, B.Pd. . . . . The Davenport.
Professor of Physical Education and Hygiene and Head of Department.

Mrs. Curry S. Hicks . . . . The Davenport.
Instructor in Physical Education.

Dwight Hughes, Jr., Captain, Cavalry, U. S. A. . . . . The Davenport.
Assistant Professor of Military Science and Tactics.

Belding F. Jackson, B.Sc. . . . . Belchertown.
Instructor in English.

Henry F. Judkins, B.Sc. . . . . 103 Butterfield Terrace.
Professor of Dairying and Head of Department.

Arthur N. Julian, A.B. . . . . 4 Farview Way.
Professor of German.

Daniel J. Keane, Captain, Cavalry, U. S. A. . . . . . The Davenport.
Assistant Professor of Military Science and Tactics.

Paul Keller, B.Sc. . . . . 81 Pleasant Street.
Instructor in German.

Helen Knowlton, A.M. . . . . 3 McClellan Street.
Assistant Professor of Home Economics.

Marshall O. Lanphear, B.Sc. . . . . 4 Nutting Avenue.
Assistant Professor of Agronomy.

John B. Lentz, A.B., V.M.D. . . . . 3 Dana Street.
Assistant Professor of Veterinary Science and College Veterinarian.

Joseph B. Lindsey, Ph.D. . . . . 47 Lincoln Avenue.
Goessmann Professor of Agricultural Chemistry and Head of Department.

William L. Machmer, A.M. . . . . 25 Amity Street.
Professor of Mathematics, Acting Dean and Acting Registrar.

Merrill J. Mack, M.Sc.[1] . . . . 32 North Prospect Street.
Instructor in Dairying.

Alexander A. Mackimmie, A.M. . . . . North Amherst.
Professor of Economics and Sociology and Head of Department.

Miner J. Markuson, B.Sc. . . . . Farview Way.
Assistant Professor of Rural Engineering.

Charles E. Marshall, Ph.D. . . . . 10 South Prospect Street.
Professor of Microbiology and Head of Department.

Frederick A. McLaughlin, B.Sc. . . . . 4 Nutting Avenue.
Assistant Professor of Botany.

Charles A. Michels, M.Sc. . . . . 70 Lincoln Avenue.
Assistant Professor of Agronomy.

Enos J. Montague, B.Sc. . . . . Campus.
Assistant Professor of Farm Practice and Farm Superintendent.

Frank C. Moore, A.B. . . . . 10 Allen Street.
Assistant Professor of Mathematics.

Harry T. Mortensen, B.Sc. . . . . Sunderland.
Instructor in Microbiology.

Richard T. Muller, M.Sc. . . . . 45 East Pleasant Street.
Assistant Professor of Floriculture.

John B. Newlon . . . . North Amherst.
Instructor in Rural Engineering.

A. Vincent Osmun, M.Sc. . . . . 16 Northampton Road.
Professor of Botany and Head of Department.

John E. Ostrander, A.M., C.E. . . . . . . 33 North Prospect Street.
Professor of Mathematics and Head of Department.

Charles H. Patterson, A.M. . . . . 26 Lincoln Avenue.
Professor of English.

Harlow L. Pendleton, B.Sc. . . . . Fearing Street.
Instructor in Dairying.

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[1] Temporary for one year.

Charles A. Peters, Ph.D. . . . . Sunset Place.
Professor of Inorganic and Soil Chemistry.

Wallace F. Powers, Ph.D. . . . . 7 Allen Street.
Professor of Physics and Head of Department.

Walter E. Prince, A.M. . . . . 27 Amity Street.
Assistant Professor of English.

Marion C. Pulley, B.Sc. . . . . 68 Lincoln Avenue.
Instructor in Poultry Husbandry.

George F. Pushee . . . . North Amherst.
Instructor in Rural Engineering.

Leon R. Quinlan, M.L.A. . . . . Tyler Place.
Assistant Professor of Landscape Gardening.

George J. Raleigh, M.Sc. . . . . 7 East Pleasant Street.
Instructor in Pomology.

Frank Prentice Rand, A.M. . . . . 3 Mount Pleasant.
Assistant Professor of English.

Victor A. Rice, M.Agr. . . . . 35 Woodside Avenue.
Assistant Professor of Animal Husbandry.

Gordon C. Ring, A.M. . . . . 42 Lincoln Avenue.
Instructor in Zoölogy.

William F. Robertson, B.Sc. . . . . . . 33 East Pleasant Street.
Instructor in Horticultural Manufactures.

William C. Sanctuary, B.Sc. . . . . 11 Cottage Street.
Professor of Poultry Husbandry.

Donald W. Sawtelle, M.Sc. . . . . 5 Allen Street.
Assistant Professor of Agricultural Economics.

Fred C. Sears, M.Sc. . . . . Mount Pleasant.
Professor of Pomology and Head of Department.

Paul Serex, Jr., Ph.D. . . . . Lincoln Avenue.
Assistant Professor of Chemistry.

George F. Shumway, B.Sc. . . . . Inwood.
Instructor in Mathematics.

Newell L. Sims, Ph.D.[1]
Professor of Rural Sociology.

Edna L. Skinner, B.Sc. . . . . 50 Lincoln Avenue.
Professor of Home Economics, Head of Department, Adviser of Women.

Harold W. Smart, LL.B.[2] . . . . Lincoln Block.
Instructor in Farm Law.

Richard W. Smith, Jr., B.Sc.[1]
Instructor in Dairying.

Grant B. Snyder, B.Sc.Agr. . . . . Lincoln Block.
Instructor in Vegetable Gardening.

Orman E. Street, B.Sc. . . . . East Experiment Station.
Instructor in Agronomy.

Charles H. Thayer . . . . South East Street.
Instructor in Agronomy.

Clark L. Thayer, B.Sc. . . . . North Amherst.
Professor of Floriculture and Head of Department.

Charles H. Thompson, M.Sc. . . . . Mount Pleasant.
Professor of Horticulture.

Ray E. Torrey, Ph.D. . . . . Inwood.
Assistant Professor of Botany.

Malcomb E. Tumey, B.Sc. . . . . 3 Allen Street.
Instructor in Physical Education.

Ralph A. Van Meter, B.Sc. . . . . 7 East Pleasant Street.
Professor of Pomology.

Paul W. Viets . . . . Sunset Avenue.
Supervisor of Placement Training.

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[1] Absent on leave. [2] Temporary for one year.

Frank A. Waugh, M.Sc. . . . . Campus.
Professor of Landscape Gardening, Head of Department, Head of Division of Horticulture.
Winthrop S. Welles, B.Sc. . . . . 23 Lincoln Avenue.
Professor of Agricultural Education and Head of Department.
T. George Yaxis, M.Sc. . . . . 5 Sunset Avenue.
Assistant Professor of Dairying.

—— ——
Professor of Animal Husbandry and Head of Department.

—— ——
Professor of Rural Sociology and Head of Department.

—— ——
Assistant Professor of Vegetable Gardening.

—— ——
Instructor in Animal Husbandry.

The Experiment Station Staff.

Edward M. Lewis, A.M. . . . . President's House.
Dean and Acting President of the College.
Sidney B. Haskell, B.Sc. . . . . 2 Mount Pleasant.
Director.
James R. Alcock . . . . North Amherst.
Laboratory Assistant in Animal Nutrition.
Harry L. Allen . . . . 89 Main Street.
Laboratory Assistant in Chemistry.
John G. Archibald, M.Sc. . . . . North Amherst.
Assistant Research Professor of Chemistry.
Theodore T. Ayers, B.Sc. . . . . Inwood.
Investigator in Botany.
John S. Bailey, M.Sc. . . . . 13½ Amity Street.
Investigator in Pomology.
Alyn S. Ball . . . . 94 Main Street.
Laboratory Assistant in Botany.
Arthur B. Beaumont, Ph.D. . . . . 51 Amity Street.
Professor of Agronomy and Head of Department.
Arthur I. Bourne, B.A. . . . . 12 East Pleasant Street.
Assistant Research Professor of Entomology.
Leon A. Bradley, Ph.D. . . . . North Amherst.
Assistant Research Professor of Microbiology.
Alexander E. Cance, Ph.D. . . . . 9 Fearing Street.
Professor of Agricultural Economics and Head of Department.
Walter W. Chenoweth, M.Sc. . . . . North Amherst.
Professor of Horticultural Manufactures and Head of Department.
Orton L. Clark, B.Sc. . . . . 12 College Street.
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Walter L. Cutler . . . . North Pleasant Street.
Laboratory Assistant in Pomology.
William L. Doran, M.Sc. . . . . 16 Nutting Avenue.
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F. Ethel Felton, B.A. . . . . The Davenport.
Editorial Assistant.
Henry T. Fernald, Ph.D. . . . . 44 Amity Street.
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James A. Foord, M.Sc.Agr. . . . . 54 Lincoln Avenue.
Professor of Farm Management and Head of Department.
Henry J. Franklin, Ph.D. . . . . East Wareham.
Research Professor in charge of Cranberry Station.
George E. Gage, Ph.D. . . . . The Davenport.
Professor of Animal Pathology and Head of Department of Veterinary Science and Animal Pathology.

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John E. Ostrander, A.M., C.E. . . . . 33 North Prospect Street.
Meteorologist.
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Assistant Research Professor of Avian Pathology.
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Fred C. Sears, M.Sc. . . . . Mount Pleasant.
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Victor A. Tiedjens, M.Sc. . . . . Waltham.
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Frank A. Waugh, M.Sc. . . . . Campus.
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Warren D. Whitcomb, B.Sc. . . . . Waltham.
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Control Service Staff.

Patrick E. Bransfield, B.A. . . . . 14 Nutting Avenue.
Analyst.
George B. Dalrymple . . . . 29 Main Street.
Analyst.
Wilbert D. Field, B.Sc. . . . . Baker Place.
Collector of Blood Samples.
Henri D. Haskins, B.Sc. . . . . Easthampton.
Official Chemist, Fertilizer Control.
James T. Howard . . . . 7 Phillips Street.
Inspector.
Frank J. Kokoski, B.Sc. . . . . Northampton Road.
Analyst.
Mrs. Leila Prescott . . . . Pelham Road.
Analyst.
Harold F. Rowley, B.Sc. . . . . 15 Hallock Street.
Technical Assistant.
Philip H. Smith, M.Sc. . . . . 102 Main Street.
Official Chemist, Feed Control.
Lewell S. Walker, B.Sc. . . . . 19 Phillips Street.
Assistant Official Chemist, Fertilizer Control.

Extension Service Staff.

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Dean and Acting President of the College.
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Director.
Fayette H. Branch, B.Sc. . . . . 31 East Pleasant Street.
Extension Professor of Farm Management.
William R. Cole . . . . Fearing Street.
Assistant Extension Professor of Horticultural Manufactures.
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May E. Foley, M.A. . . . . 87 Pleasant Street.
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Robert D. Hawley, B.Sc. . . . . South Amherst.
Supervisor of Correspondence Courses and Extension Courses at the College.
William F. Howe . . . . North Amherst.
Assistant State Leader of County Club Agents.
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Extension Instructor in charge of Poultry Club Work.
Sumner R. Parker, B.Sc. . . . . South Amherst.
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Assistant Director.
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State Leader of County Home Demonstration Agents.

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Extension Professor of Agronomy.
—— ——
Extension Editor.

The Library Staff.

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Librarian.
Lena V. Chapman . . . . 77 South Pleasant Street.
Assistant in charge of circulation.
Katharine Powell . . . . 9 Amity Street.
Department Librarian.
Bessie M. Weymouth . . . . 116 Pleasant Street.
Cataloguer.
—— ——
Library Assistant.

Other Officers.

Baldassaros E. A. Bovenzi . . . . 61 Amity Street.
Engineer.
John K. Broadfoot . . . . 130 Pleasant Street.
Assistant to the Treasurer.
Avis P. Christopher . . . . Infirmary.
Resident Nurse.
Lawrence S. Dickinson, B.Sc. . . . . 2 Farview Way.
Superintendent of Grounds.
Lulu Diether . . . . Draper Hall.
Manager of the Dining Hall.
Samuel C. Hubbard . . . . North Amherst.
Foreman Department of Floriculture.
Clarence A. Jewett . . . . 112 Pleasant Street.
Superintendent of Buildings.
John J. Lee . . . . 38 Cottage Street.
Assistant to the Military Detail.
Mrs. Mary Macrae . . . . Infirmary.
Matron.
Mrs. Marie B. Marsh . . . . Abigail Adams House.
Matron.
Ural V. Martin . . . . 79 Main Street.
Curator, Goessmann Laboratory.
William E. Martin . . . . 5 Phillips Street.
Laboratory Assistant, Department of Horticultural Manufactures.
Enos J. Montague, B.Sc. . . . . Campus.
Farm Superintendent.
Adelbert Sheffield . . . . North Amherst.
Superintendent of Dairy Manufactures.

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Alwyn C. Sessions, B.Sc. . . . . Oneacre.
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Foster H. Weiss, B.Sc. . . . . 85 Pleasant Street.
Department of Vegetable Gardening.

Gus C. Wofford, B.Sc. . . . . 83 Pleasant Street.
Department of Landscape Gardening.

Standing Committees of the Faculty.

1925–1926.

Commencement.

Professor Thayer.
Treasurer Kenney.
Secretary Watts.
Mr. S. R. Parker.
Asst. Professor Clark.

Course of Study.

Acting President Lewis.
Professor Waugh.
Professor Fernald.
Professor Ostrander.
Professor Marshall.
Professor Chamberlain.
Professor Foord.
Professor Welles.
Professor Julian.

Discipline.

Professor Mackimmie.
Acting Dean Machmer.
Professor Chenoweth.
Professor Hicks.
Professor Gunness.

Employment.

Professor Judkins.
Treasurer Kenney.
Secretary Watts.
Professor Thayer.

Academic Activities Board.

Professor Waugh.
Acting Dean Machmer.

Entrance Examinations and Admission.

Acting Dean Machmer.
Professor Patterson.
Professor Osmun.
Professor Ashley.
Professor Glick.

Health and Sanitation.

Professor Marshall.
Treasurer Kenney.
Professor Gage.
Professor Hicks.
Miss Skinner.

Library.

Professor Marshall.
Professor Patterson.
Professor Cance.
Mr. Wood.

Scholarship.

Acting President Lewis.
Acting Dean Machmer.
Professor Peters.
Professor Mackimmie.
Professor Patterson.
Asst. Professor Rand.
Asst. Professor Torrey.
Asst. Professor Rice.

Student Life.

Professor Thayer.
Secretary Watts.
Professor Sears.
Professor Mackimmie.
Director Verbeck.
Professor Hicks.

Athletic Board.

Acting Dean Machmer.
Professor Osmun.
Asst. Professor Rice.

ADMISSION.

A. APPLICATION FOR ADMISSION.

Correspondence concerning admission should be addressed to the registrar.

Every applicant for admission to the college must be at least sixteen years old, and must present to the registrar proper testimonials of character, which, whenever possible, should come from the principal of the school at which the applicant has prepared for college. Candidates who desire to present themselves for examination in any subjects must make application to the college for such privilege at least one month before the date of the examination. Blanks for such application may be obtained by addressing the registrar of the college. All entrance credentials must be in the hands of the registrar before the applicant can matriculate.

B. MODES OF ADMISSION.

Students are admitted to the freshman class either upon certificate or upon examination. No *diploma* from a secondary school will be accepted.

CERTIFICATES. — The Massachusetts Agricultural College is affiliated with the New England College Entrance Certificate Board. Therefore certificates of admission will be accepted from schools approved by the Board. Certificates of admission will also be accepted from any Massachusetts school listed as class "A" by the State Department of Education, but not included in the approved lists of the New England College Entrance Certificate Board. Principals of schools in New England who desire the certificate privilege should address the secretary of the Board, Professor Frank W. Nicolson, Wesleyan University, Middletown, Conn. Certificates from schools outside of New England may be received if those schools are on the approved list of the leading colleges of the section in which the school in question is located.

The credentials of the Board of Regents of the State of New York are accepted as satisfying the entrance requirements of this college when offered subject for subject.

Certificates in order to be accepted must present in the prescribed and restrictive elective groups at least three of the necessary fourteen and one-half credits. It is to be understood, however, that responsibility for certification in either elementary French, elementary German, English 1 or English 2, Latin A, Greek A or algebra must be assumed by one school, if the candidate has received his preparation in any one subject named above in more than one school. Subjects lacking on certificate (except for the permitted number of conditions) must be made up at the time of the examinations for admission.

SPECIAL CERTIFICATE ARRANGEMENT FOR STUDENTS FROM AGRICULTURAL SCHOOLS. — Superior graduates of Vocational Schools of Agriculture in Massachusetts may be accepted for the Degree of Vocational Agriculture provided:

(*a*) they are unqualifiedly recommended by the Vocational Division of the State Department of Education;

(*b*) that they can present at least 14½ units of certified entrance credits.

Graduates of Vocational Agricultural Departments in Massachusetts High Schools may be admitted to the same degree course provided they present 14½ certified units of work. At least 7½ units must be in subjects listed in the "prescribed" and "restricted elective" groups certified to by the High School Principal in the regular way. The other 7 units will be accepted for work done in the Agricultural Department and approved both as to quality and quantity by the State Department of Vocational Education.

Blank forms for certification — sent to principals or school superintendents only — may be obtained on application to the registrar of the college.

Examinations. — The examination in each subject may be oral or written, or both. The standard required for passing an examination for admission is 65 per cent. Conditions to the amount of two units will be allowed.

Entrance examination for admission to the Massachusetts Agricultural College will be held at the following centers: —

In June	Amherst, Stockbridge Hall. Massachusetts Institute of Technology, Cambridge, Mass. Worcester, Worcester Polytechnic Institute.
In September . . .	Amherst, Stockbridge Hall.

Please note that September examinations are held in Amherst only.

Schedule for Entrance Examinations June 17–19, 1926.

First Day.

8.30 A.M.	Algebra.
10.30 A.M.	Chemistry.
2.00 P.M.	History (ancient, medieval and modern, English, general, United States and Civics).

Second Day.

8.30 A.M.	English 1 and 2.
11.30 A.M.	Botany.
2.00 P.M.	Plane Geometry.
3.30 P.M.	Physics.

Third Day.

8.30 A.M.	French, German, Spanish, required and elective.
1.00 P.M.	Latin, elementary, intermediate and advanced, and all one-half credit electives, except those already noted.

Schedule for Entrance Examinations September 8–11, 1926.

First Day.

1.15–5.00 P.M.	Greek, elementary and intermediate.

Second Day.

8.30 A.M.	Algebra.
10.30 A.M.	Chemistry.
2.00 P.M.	History (ancient, medieval and modern, English, general, United States and Civics).

Third Day.

8.30 A.M.	English 1 and 2.
11.30 A.M.	Botany.
2.00 P.M.	Plane Geometry.
3.30 P.M.	Physics.

Fourth Day.

8.30 A.M.	French, German, Spanish, required and elective.
1.00 P.M.	Latin, elementary, intermediate and advanced, and all one-half credit electives, except those already noted.

C. Requirements for Admission.

The requirements for admission are based on the completion of a four-year high school course, or its equivalent, and are stated in terms of units. The term unit means the equivalent of at least four recitations a week for a school year.

Fourteen and one-half units must be offered for admission in accordance with the entrance requirements as stated below. Entrance credits gained either by certificate or by examination will hold good for one year.

Entrance Requirements.

1. *Prescribed.* — The following units are prescribed: —

English 1	$1\frac{1}{2}$
English 2	$1\frac{1}{2}$
A foreign language	2
Algebra	$1\frac{1}{2}$
Plane geometry	1
	$7\frac{1}{2}$

2. *Restricted Electives.* — Three units to be selected from —

Science	1, 2 or 3
History (American history and civics included)	1, 2 or 3
A second foreign language	2 or 3
Additional work, in first foreign language	1 or 2

3. *Free Margin.* — Free margin of four units to consist of any substantial work (including agriculture, general science and a fourth year of English) for which credit of not less than one-half unit earned in one year is given toward a secondary school diploma.

"Units presented in the free margin group in subjects not included in the examination schedule may be offered only by certificate."

4. One unit of history must be offered in either the restricted electives or the free margin.

5. If elementary algebra and plane geometry are counted as three units, the total requirement will be fifteen units.

6. Both the cıedits under the prescribed group and the restricted elective group must be presented either by certificate from an approved school or by examination, or by a combination of both.

The following is a list of subjects in which the entrance credits must be offered in the prescribed and restricted elective groups: —

Mathematics and Science.

Botany[1]	$\frac{1}{2}$ or 1
Chemistry[1]	1
Algebra	$1\frac{1}{2}$
Plane geometry	1
Solid geometry	$\frac{1}{2}$
Trigonometry	$\frac{1}{2}$
Physics[1]	1
Geology	$\frac{1}{2}$
Physical geography	$\frac{1}{2}$
Physiology	$\frac{1}{2}$
Zoölogy[1]	$\frac{1}{2}$

[1] Note-Books. — The keeping of a note-book is required as part of the preparation in those subjects indicated. Candidates presenting themselves for examination in such subjects must present at the same time a statement signed by the Principal to the effect that a satisfactory note-book has been kept by the candidate.

History.

Ancient	1
Medieval and modern	1
English	1
General	1
United States and civics	1

English.

English 1	1½
English 2	1½

Foreign Language.

Elementary French	2
Elementary German	2
Elementary Spanish	2
Elementary Latin	2
Elementary Greek[1]	2
Intermediate French	1
Intermediate German	1
Intermediate Spanish	1
Intermediate Latin	1
Intermediate Greek[1]	1
Advanced French	1
Advanced German	1
Advanced Spanish	1
Advanced Latin	1

No applicant deficient in both algebra and plane geometry will be admitted.

D. Statement of Preparation Required for Admission.

Agriculture. — Entrance credit in agriculture is granted on the following basis: —

I. The Massachusetts Agricultural College accepts a maximum of four credits in agriculture from any secondary or county agricultural high school in Massachusetts offering work in that subject, provided evidence of such work having been done is submitted on a principal's statement, as is indicated in the "free margin" group.

II. In high schools organizing agricultural club work under the supervision and rules of the junior extension service of the college, one credit is granted for each full year of work performed under the following plan: —

Work of the Winter Term. — (*a*) The study of textbooks such as are suitable for secondary school instruction in agriculture.

(*b*) Course of Study: A general outline of suggested topics for study.

(*c*) Visits by a representative of the Massachusetts Agricultural College for observation, counsel and advice in regard to kind and amount of work being done in agriculture.

(*d*) Formation of an agricultural club with officers from among its own members, meeting once a month under local supervision of some one authorized to act for the school authorities.

Work of the Spring Term. — Same in general form as winter term.

Work of the Summer Term. — An approved project conforming to the rules of some one or more of the agricultural clubs of the junior extension service of the Massachusetts Agricultural College.

Work of the Fall Term. — (*a*) An exhibit of work.

(*b*) Reports and story of achievement submitted to the junior extension service of the college.

The maximum number of credits in agriculture is four.

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[1] Examination in September only.

Botany. — For one unit of credit in botany, the work outlined in the statement of requirements issued by the College Entrance Examination Board, or its equivalent, will be accepted. This work should occupy one school year and include laboratory and supplementary textbook study. For one-half unit of credit, work that covers the same ground but occupies half the time required for a full unit of credit will be accepted. These requirements are met by such texts as Stevens' "Introduction to Botany" and Bergen & Davis' "Principles of Botany." A note-book, containing neat, accurate drawings and descriptive records forms part of the requirement for either the half-unit or the one-unit credit, and this note-book must be presented by all applicants for admission upon examination in this subject. The careful preparation of an herbarium is recommended to all prospective students of this college, although the herbarium is not required.

Chemistry. — The entrance examination in chemistry will cover the work outlined by the College Entrance Examination Board as preparatory for college entrance. In general, this consists of a year of high school chemistry from any standard textbook, with laboratory work on the properties of the common elements and their simpler compounds. No particular work is prescribed. The keeping of a note-book is required.

Students who do not take chemistry in the preparatory school begin the subject in college, and are required to do extra work during the first two terms, as outlined under chemistry, courses 1 and 2, pages 65 and 66.

Mathematics. — (a) *Required.* — Algebra: The four fundamental operations for rational algebraic expressions; factoring, determination of highest common factor and lowest common multiple by factoring; fractions, including complex fractions; ratio and proportion; linear equations, both numerical and literal, containing one or more unknown quantities; problems depending on linear equations; radicals, including the extraction of the square root of polynomials and numbers; exponents, including the fractional and negative; quadratic equations, both numerical and literal; simple cases of equations with one or more unknown quantities that can be solved by the methods of linear or quadratic equations; problems depending upon quadratic equations; the binomial theorem for positive integral exponents, the formulas for the nth term and the sum of the terms of arithmetic and geometric progressions, with applications.

Plane Geometry: The usual theorems and constructions of good textbooks, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas; regular polygons and the measurement of the circle; the solution of numerous original exercises, including loci problems; applications to the mensuration of lines and plane surfaces.

(b) *Elective.* — Solid Geometry: The usual theorems and constructions of good textbooks, including the relations of planes and lines in space; the properties and measurement of prisms, pyramids, cylinders and cones; the sphere and spherical triangle; the solution of numerous original exercises, including loci problems; applications to the mensuration of surfaces and solids.

Plane Trigonometry: A knowledge of the definitions and relations of trigonometric functions and of circular measurements and angles; proofs of the principal formulas and the application of these formulas to the transformation of the trigonometric functions; solution of trigonometric equations, the theory and use of logarithms, and the solution of right and oblique triangles.

Physics. — To satisfy the entrance requirement in physics, the equivalent of at least one unit of work is required. This work must consist of both classroom work and laboratory practice. The work covered in the class-room should be equal to that outlined in Hall & Bergen's "Textbook of Physics" or Millikan & Gale; the laboratory work should represent at least thirty-five experiments involving careful measurements, with accurate recording of each in laboratory note-book. This note-book, certified by the instructor in the subject, must be submitted by each candidate presenting himself for examination in physics; credit for passing the subject will be given on laboratory notes and on the examination submitted. Candidates entering on certificate will not be required to present note-books, but the principal's certification must cover laboratory as well as class-room work.

Physiology. — Hough & Sedgwick's "The Human Mechanism;" Martin's "The Human Body; Briefer Course."

Zoölogy, Physical Geography, Geology. — The following suggestions are made concerning preparation for admission in the subjects named above: —

For physiography, Davis' "Elementary Physical Geography;" Gilbert & Brigham's "Introduction to Physical Geography." For zoölogy, textbooks entitled "Animals" or "Animal Studies," by Jordan, Kellogg and Heath; Linville & Kelley's "A Textbook in General Zoölogy." For geology, A. P. Brigham's "A Textbook of Geology" or Tarr's "Elementary Geology."

Applicants for examination in zoölogy are *required* to present certified laboratory note-books; applicants for examination in the other subjects are *advised* to present note-books, if laboratory work has been done. Good note-books may be given credit for entrance. Examination in these subjects will be general, in recognition of the different methods of conducting courses; but students will be examined on the basis of the most thorough secondary school courses.

History. — The required unit must be offered in either ancient history, medieval and modern history, English history, general history, or United States history and civics. Either one, two or three elective units in any of the historical subjects here named may be offered, provided that no unit be offered in the same subject in which the required unit has been offered.

Preparation in history will be satisfactory if made in accordance with the recommendations of the committee of seven of the American Historical Association, as outlined by the College Entrance Examination Board. The examination will require comparisons and the use of judgment by the candidate rather than the mere use of memory, and it will presuppose the use of good textbooks, collateral reading and practice in written work. Geographical knowledge may be tested by requiring the location of places and movements on outline maps.

To indicate in a general way the character of the textbook work expected, the texts of the following authors are suggested: Botsford, Morey or Myers, in ancient history (to 814 A.D.); Adams, West or Myers, in medieval history; Montgomery, Larned or Cheyney, in English history; Myers or Fisher, in general history; Fiske, together with MacLaughlin or Montgomery, in United States history and civics.

English. — The study of English in school has two main objects, which should be considered of equal importance: (1) command of correct and clear English, spoken and written; (2) ability to read with accuracy, intelligence and appreciation, and the development of the habit of reading good literature with enjoyment.

(1) *Grammar and Composition* (One and One-half Units). — The first object requires instruction in grammar and composition. English grammar should ordinarily be reviewed in the secondary school; and correct spelling and grammatical accuracy should be rigorously exacted in connection with all written work during the four years. The principles of English composition governing punctuation, the use of words, sentences and paragraphs should be thoroughly mastered; and practice in composition, oral as well as written, should extend throughout the secondary school period. Written exercises may well comprise letter-writing, narration, description and easy exposition and argument. It is advisable that subjects for this work be taken from the student's personal experience, general knowledge and studies other than English, as well as from his reading in literature. Finally, special instruction in language and composition should be accompanied by concerted effort of teachers in all branches to cultivate in the student the habit of using good English in his recitations and various exercises, whether oral or written.

(2) *Literature* (One and One-half Units). — The second object is sought by means of two lists of books, headed, respectively, "Reading" and "Study," from which may be framed a progressive course in literature covering four years. In connection with both lists the student should be trained in reading aloud and encouraged to commit to memory some of the more notable passages both in verse and in prose. As an aid to literary appreciation, he is further advised to acquaint himself with the most important facts in the lives of the authors whose works he reads and with their place in literary history.

A. Books for Reading. — The aim of this course is to foster in the student the habit of intelligent reading and to develop a taste for good literature by giving him a first-hand knowledge of some of its best specimens. He should read the books carefully, but his attention should not be so fixed upon details that he fails to appreciate the main purpose and charm of what he reads.

The books provided for reading are arranged in the following groups, from each of which at least two selections are to be made, except that for any book in Group I a book from any other may be substituted.

Group I. Classics in Translation.

The "Old Testament," at least the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings and Daniel, together with the books of Ruth and Esther.
The "Odyssey," with the omission, if desired, of Books I–V, XV and XVI.
The "Æneid."
The "Odyssey" and the "Æneid" should be read in English translations of recognized literary excellence.

Group II. Drama.

Shakespeare: "Merchant of Venice," "As You Like It," "Julius Cæsar."

Group III. Prose Fiction.

Dickens: "A Tale of Two Cities."
George Eliot: "Silas Marner."
Scott: "Quentin Durward."
Hawthorne: "The House of the Seven Gables."

Group IV. Essays, Biography, etc.

Addison and Steele: "The Sir Roger de Coverley Papers."
Irving: "The Sketch Book," selections covering about 175 pages.
Macaulay: "Lord Clive."
Parkman: "The Oregon Trail."

Group V. Poetry.

Tennyson: "The Coming of Arthur," "Gareth and Lynette," "Lancelot and Elaine," "The Passing of Arthur."
Browning: "Cavalier Tunes," "The Lost Leader," "How They Brought the Good News from Ghent to Aix," "Home Thoughts from Abroad," "Home Thoughts from the Sea," "Incident of the French Camp," "Hervé Riel," "Pheidippides," "My Last Duchess," "Up at a Villa — Down in the City," "The Italian in England," "The Patriot," "The Pied Piper," "De Gustibus," "Instans Tyrannus."
Scott: "The Lady of the Lake."
Coleridge: "The Ancient Mariner."
Arnold: "Sohrab and Rustum."

B. Books for Study. — This part of the requirement is intended as a natural and logical continuation of the student's earlier reading, with greater stress laid upon form and style, the exact meaning of words and phrases, and the understanding of allusions.

The books provided for study are arranged in four groups, from each of which one selection is to be made.

Group I. Drama.

Shakespeare: "Macbeth," "Hamlet."

Group II. Poetry.

Milton: "L'Allegro," "Il Penseroso," "Comus."
Book IV of Palgrave's "Golden Treasury" (first series), with special attention to Wordsworth, Keats and Shelley.

Group III. Oratory.

Burke: "Speech on Conciliation with America."
Washington's "Farewell Address," Webster's "First Bunker Hill Oration," and Lincoln's "Gettysburg Address."

Group IV. Essays.

Macaulay: "Life of Johnson."
Carlyle: "Essay on Burns," with a brief selection from Burns' poems.

Examination. — However accurate in subject-matter, no paper will be considered satisfactory if seriously defective in punctuation, spelling or other essentials of good usage.

The examination will be divided into two parts, one of which will be on grammar and composition, and the other on literature.

In grammar and composition, the candidate may be asked specific questions upon the practical essentials of these studies, such as the relation of the various parts of a sentence to one another, the construction of individual words in a sentence of reasonable difficulty, and those good usages of modern English which one should know in distinction from current errors. The main test in composition will consist of one or more essays, developing a theme through several paragraphs; the subjects will be drawn from the books read, from the candidate's other studies and from his personal knowledge and experience quite apart from reading.

The examination in literature will include: —

(*a*) General questions designed to test such a knowledge and appreciation of literature as may be gained by fulfilling the requirements defined under "A, Reading," above.

(*b*) A test on the books prescribed for study, which will consist of questions upon their content and structure, and upon the meaning of such words, phrases and allusions as may be necessary to an understanding of the works and an appreciation of their salient qualities of style. General questions may also be asked concerning the lives of the authors, their works and the periods of literary history to which they belong.

French. — Elementary: The necessary preparation for this examination is stated in the description of the two-year course in elementary French recommended by the Modern Language Association, contained in the definition of requirements of the College Entrance Examination Board.

Third and fourth year French (elective subjects for admission). — For a third credit unit in French as an elective subject for entrance, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in French will be given unless the candidate has presented elementary French on certificate, or has written the examination in elementary French.

No examination for a fourth credit in French will be given unless the candidate has presented both elementary and intermediate French upon certificate, or has written the examination in both elementary and intermediate French.

German. — Elementary: The entrance requirements in German conform to those of the College Entrance Examination Board for elementary German (the standard two-year requirements).

Third and fourth year German (elective subjects for admission). — For a third credit unit in German as an elective subject for entrance, when required units have been offered in German, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in German will be given unless the candidate has presented elementary German upon certificate, or has written the examination in elementary German.

No examination for a fourth credit in German will be given unless the candidate has presented both elementary and intermediate German upon certificate, or has written the examination for both elementary and intermediate German.

Spanish. — Elementary: The necessary preparation for this examination is stated in the description of the two-year course in elementary Spanish recommended by the Modern Language Association, contained in the definition of requirements of the College Entrance Examination Board.

Third and fourth year Spanish (elective subjects for admission). — For a third credit unit in Spanish as an elective subject for entrance, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in Spanish will be given unless the candidate has presented elementary Spanish on certificate, or has written the examination in elementary Spanish.

No examination for a fourth credit in Spanish will be given unless the candidate has presented both elementary and intermediate Spanish upon certificate, or has written the examination in both elementary and intermediate Spanish.

Greek. — *Elementary.* — Greek grammar and composition: Translation into Greek of short sentences illustrating common principles of syntax.

The examination in grammar and prose composition will be based on the first four books of Xenophon's "Anabasis."

Intermediate. — Homer's "Iliad," Books I and II (omitting Book II, 494 to end), and the Homeric forms, constructions, idioms and prosody.

Prose composition, consisting of continuous prose based on Xenophon, and other Attic prose of similar difficulty.

Translation of passages of Homer at sight.

The examinations in Greek, elementary and intermediate, will be given in September only.

Latin. — *Elementary.* — Two credit units will be allowed if satisfactory proficiency is shown (including grammar) in (*a*) the translation of a passage or passages taken from Cæsar's "Gallic War," covering at least four books, and (*b*) the translation of passages of Latin prose at sight.

Intermediate. — Cicero (third oration "Against Catiline" and the orations "For Archias" and "For Marcellus") and sight translation of prose.

Advanced. — Vergil (Æneid, II, III and VI) and sight translation of poetry.

E. Admission to Advanced Standing.

Candidates for admission to advanced standing, in addition to meeting the regular entrance requirements, must also pass examinations in those subjects already pursued by the class they desire to enter. To meet this requirement, a student transferring to this college from another college or university of recognized standing must present the following credentials: —

1. A letter of honorable dismissal from the institution with which he has been connected.
2. A statement or certificate of his entrance record.
3. A statement from the proper officer showing a complete record of his work while in attendance.
4. A marked catalogue showing the courses pursued.
5. A statement from the proper officer, giving the total number of credits required for graduation by the institution from which the applicant is transferring, and, of this total, the number that the applicant has satisfactorily completed at the time of transfer.

These credentials should be presented to the registrar. Applications will be judged wholly on their merits and the college may prescribe additional tests before accepting applicants or determining the standing to be granted them.

F. Other Information about Entrance.

1. The privileges of the college may be withdrawn from any student at any time if such action is deemed advisable. (It is immaterial whether the pupil has entered by certificate or by examination.)
2. The examination in each subject may be either oral or written, or both. The standard required for passing an entrance examination is 65 per cent.

3. To matriculate, candidates must offer twelve and one-half of the fourteen and one-half units required for admission, and will be conditioned in those subjects not passed. At least five and one-half credits must be in the prescribed group. No candidate deficient in both algebra and plane geometry will be admitted.

4. Examinations for the removal of entrance conditions will be held during the first week of the second term.

5. Credits for entrance requirements, whether gained by certificate or by examination, will hold good for one year.

6. Examinations in part of the subjects required for entrance may be taken one year before entering college.

7. For information concerning expenses, scholarships, etc., see "General Information."

8. For information concerning admission to short courses, see "Short Courses."

9. Application for admission as a "Special Student" should be made to the Dean.

COURSES OF INSTRUCTION.

FRESHMAN YEAR.

TABLE OF FRESHMAN SUBJECTS.

[Groups A and B of each term are required of all Freshman men: groups A and C of all Freshman women. For details, see the following tables of the first, second, and third terms, and the description of the courses.]

First Term.

COURSE AND NUMBER.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
Group A; for men and women:			
Agriculture 1	3	–	3
Chemistry 1	3	4	5
or			
Chemistry 4	2	4	4
English 1	3	–	3
Language 1 or 4 (French or German)	3	–	3
Mathematics 1 (Algebra)	4	–	4
Group B; for men:			
Military 1 (or Physical Education 7)	–	3	2
Physical Education 1	1	–	1
Physical Education 2	–	2	1
Group C; for women:			
Rural Home Life 1	2	–	2
Physical Education 4	–	3	2

Second Term.

COURSE AND NUMBER.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
Group A; for men and women:			
Agriculture 2	3	–	3
Chemistry 2	3	4	5
or			
Chemistry 5	2	4	4
English 2	3	–	3
Language 2 or 5 (French or German)	3	–	3
Mathematics 2 (Higher Algebra)	3	–	3
or			
Mathematics 3 (Solid Geometry)	3	–	3
Mathematics 4 (Mensuration)	2	–	2
Group B; for men:			
Military 2 (or Physical Education 8)	–	3	2
Group C; for women:			
Physical Education 5	–	3	2

Third Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
Group A; for men and women:			
Agriculture 3	3	–	3
Botany 3	2	4	4
English 3	3	–	3
Language 3 or 6 (French or German)	3	–	3
Mathematics 5 (Trig.)	3	–	3
Group B; for men:			
Military 3 (or Physical Education 9)	–	3	2
Physical Education 3	–	2	1
Group C; for women:			
Physical Education 6	–	3	2
Agriculture 6	2	–	2

SOPHOMORE YEAR.

Table of Sophomore Subjects.

[Groups A and B of each term are required of all Sophomore men; groups A and C, of all Sophomore women. In addition one of the "Divisional Elective Groups" is to be elected as a unit by each Sophomore. For details, see the following tables of the first, second, and third terms, and the description of the courses.]

First Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
Group A; for men and women:			
Botany 25	1	4	3
English 25	2	–	2
English 28	1	–	1
Physics 25	3	2	4
Group B; for men:			
Military 25 (or Physical Education 30)	–	3	2
Physical Education 25	–	2	1
Group C; for women:			
Physical Education 27	–	5	3
Divisional Elective Groups.			
Agriculture:			
Animal Husbandry 25	2	2	3
Agronomy 25	2	4	4
Horticulture:			
Chemistry 25	1	4	3
or			
Drawing 25	–	8	4
Horticulture 25	1	4	3
Science:			
Modern Language (French or German)	3	–	3
Chemistry 25	1	4	3
Rural Social Science:			
Economic Sociology 25	5	–	5
Rural Home Life:			
Landscape Gardening 30	–	6	3
Rural Home Life 28	1	6	4

Second Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
Group A; for men and women:			
English 26	2	–	2
English 29	1	–	1
Zoölogy 26	2	4	4
Group B; for men:			
Military 26 (or Physical Education 31)	–	3	2
Group C; for women:			
Physical Education 28	–	3	2
Divisional Elective Groups.			
Agriculture:			
Animal Husbandry 26	2	2	3
Chemistry 30	3	4	5
Physics 26	3	2	4
Horticulture:			
Physics 26	3	2	4
Horticulture 26	1	4	3
Agricultural Economics 26	4	2	5
Science:			
Modern Language (French or German)	3	–	3
Physics 26	3	2	4
Chemistry 26	1	4	3
Rural Social Science:			
Agricultural Economics 26	4	2	5
Agricultural Education 29	3	–	3
History and Government 25	3	–	3
Landscape Gardening:			
Physics 26	3	2	4
Mathematics 26	3	–	3
Drawing 26	–	6	3
Rural Home Life:			
Chemistry 30	3	4	5
Rural Home Life 29	1	6	4
Rural Home Life 32	–	6	3

Third Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
Group A; for men and women:			
English 27	2	–	2
Group B; for men:			
Military 27 (or Physical Education 32)	–	3	2
Physical Education 26	–	2	1
Group C; for women:			
Physical Education 29	–	5	3
Divisional Elective Groups.			
Agriculture:			
Agronomy 27	3	2	4
Microbiology 30	–	6	3
Rural Engineering 27	–	4	2
Rural Engineering 30	–	8	4
or			
Physics 27	3	2	4
English 30	1	–	1
History and Government 27	2	–	2
Horticulture:			
Agronomy 27	3	2	4
Entomology 28	2	6	5
Horticulture 27	5	–	5
English 30	1	–	1
History and Government 27	2	–	2
Science:			
Modern Language (French or German)	3	–	3
Physics 27	3	2	4
Entomology 26	5	–	5
or			
Entomology 28	2	6	5
Botany 26	1	6	4
Rural Social Science:			
Rural Sociology 27	3	–	3
Agronomy 27	3	2	4
Entomology 26	5	–	5
English 30	1	–	1
History and Government 27	2	–	2
Landscape Gardening:			
Mathematics 27	–	6	3
Drawing 27	–	8	4
Entomology 28	2	6	5
English 30	1	–	1
History and Government 27	2	–	2
Rural Home Life:			
English 30	1	–	1
Entomology 28	2	6	5
Microbiology 33	3	2	4
Rural Engineering 33	2	4	4
Rural Home Life 33	3	3	4

MAJORS: JUNIOR AND SENIOR YEARS.

General Statement.

A major consists of 60 credit hours of correlated work, which is arranged by the student and his adviser.

The list of courses found under each major on subsequent pages should not be considered as necessarily a rigid program to be followed. The heads of departments have suggested this series of courses as the best for the average man majoring in their departments. Advisers may, however, make modifications to suit the particular needs of the student, provided these modifications conform precisely to the class schedule as published for the year.

Rules governing Majors.

Rule 1. *Election.* — Each student, before the first term of his junior year, shall elect a major subject from the list of majors given below; and this major shall consist of 60 credit hours of correlated work.

Rule 2. *Minimum Credits.* — The minimum number of credits for graduation shall be 120 junior-senior credit-hours in addition to the satisfactory completion of the required courses of the freshman year and of the required and elective groups of the sophomore year.

Rule 3. *Maximum Credits.* — The maximum number of credits for any term of the junior or senior year shall be 22; the minimum shall be 19.

Rule 4. *Humanities and Rural Social Science.* — A minimum of 18 credit hours in the Divisions of the Humanities and Rural Social Science will be required of all students during their junior and senior years, with the following restriction: that a minimum of 5 credit hours will be required in each of the divisions.

Rule 5. *Advisers.* — The work of each junior and senior will be under the immediate supervision of an instructor designated as major adviser. Ordinarily, the major adviser will be the head of the department in which the student elects his major. The adviser has full authority to prescribe the student's work up to 60 hours. He will, however, so far as practicable, recognize the individual needs of the student. It is also expected that students will seek the counsel of the adviser with respect to the remaining courses required for graduation.

Rule 6. *Free Electives.* — Each student during his junior and senior years is required to take 60 hours in his major and also 18 hours in the Divisions of the Humanities and Rural Social Science, making a total of 78 hours (but see Rule 4). He is allowed free choice of courses to complete his required hours.

Rule 7. *Registration.* — No junior or senior shall register until his major course of study is approved by his adviser.

(1) Course cards for recording the election of majors will be issued from the Schedule Room five weeks before the close of each term.

(2) This card must be submitted by each student to his major adviser, who will lay out the course for the succeeding term and countersign the card.

(3) Each course card must be filled out, giving the name of student, his major, his class and the name and address of parent or guardian. When the major courses have been entered on this card, and the hours of free elections added by the student, the card, accompanied by one hour plan, must be returned to the Schedule Room two weeks before the beginning of the final examination period.

Rule 8. *Change of Major.* — Applications for change of major may be made to the dean in writing at any time; when approved by both major advisers concerned and by the dean and the committee on scholarship, they become operative at the beginning of the term following, provided that no change in the selection of a major may be made by any student after registration day of his senior year.

Agronomy. (Major.)

Professor Arthur B. Beaumont, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.
Agronomy	50 **I.**	3
Agronomy	51 **III.**	3
Agronomy	75 **I.**	5
Agronomy	77 **II.**	5
Agronomy	78 **II.**	3
Animal Husbandry	50 **I.**	3
Chemistry	51 **I.**	6
Chemistry	52 **II.**	6
Farm Management	76 **I.**	3
Farm Management	77 **III.**	3
		40

Term.	Junior.	Credit.	Senior.	Credit.
I.	Agronomy 50	3	Agronomy 75	5
	Agronomy 75	5	Farm Management 76	3
	Animal Husbandry 50	3		
	Chemistry 51	6		
II.	Agronomy 78	3	Agronomy 77	5
	Chemistry 52	6	Agronomy 78	3
III.	Agronomy 51	3	Agronomy 51	3
			Farm Management 77	3

Animal Husbandry. (Major.)

Professor —— ——, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.
Agronomy	50 **I.**	3
Agronomy [1]	51 **III.**	3
Agronomy [1]	77 **II.**	5
Animal Husbandry	50 **I.**	3
Animal Husbandry	51 **II.**	3
Animal Husbandry	52 **III.**	3
Animal Husbandry	53 **III.**	5
Animal Husbandry	75 **I.**	3
Animal Husbandry	76 **II.**	3
Animal Husbandry	77 **III.**	3
Animal Husbandry	81 **II.**	1
Dairying	50 **I.**	5
Dairying [1]	52 **III.**	5
Farm Management	51 **II.**	3
Farm Management	76 **I.**	3
Farm Management [1]	81 **III.**	2
Poultry [1]	78 **III.**	5
Rural Engineering [1]	75 **I.**	5
Rural Engineering [1]	78 **II.**	5
Veterinary	50 **II.**	5
Veterinary	75 **I.**	5
or		
Veterinary	78 **I.**	3
Veterinary	76 **II.**	5
or		
Veterinary	79 **II.**	3
Veterinary	77 **III.**	5
or		
Veterinary	80 **III.**	3
		82–88 [2]

Term.	Junior.	Credit.	Senior.	Credit.
I.	Agronomy 50	3	Animal Husbandry 75	3
	Animal Husbandry 50	3	Farm Management 76	3
	Dairy 50	5	Rural Engineering 75 [1]	5
			Veterinary 75 or 78	5 or 3
II.	Animal Husbandry 51	3	Agronomy 77 [1]	5
	Farm Management 51	3	Animal Husbandry 76	3
	Veterinary 50	5	Animal Husbandry 81	1
			Rural Engineering 78 [1]	5
			Veterinary 76 or 79	5 or 3
III.	Agronomy 51 [1]	3	Agronomy 51 [1]	3
	Animal Husbandry 52	3	Animal Husbandry 77	3
	Animal Husbandry 53	5	Farm Management 81 [1]	2
	Dairying 52 [1]	5	Poultry 78 [1]	5
			Veterinary 77 or 80	5 or 3

[1] Suggested, but not required.

[2] Only 60 credit-hours required.

Dairying. (Major.)

Professor Henry F. Judkins, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics	53 **III.**	5	**I.**	Agricultural Education 51[1]	5	Agricultural Economics 83[1]	2
Agricultural Economics[1]	75 **II.**	5		Animal Husbandry 50	3	Chemistry 61	5
Agricultural Economics[1]	76 **II.**	5		Chemistry 25	3	Dairying 75	3
Agricultural Economics[1]	83 **I.**	2		Dairying 50	5	Dairying 76	4
Agricultural Economics[1]	84 **III.**	2		Dairying 75	3	Microbiology 82	5
Agricultural Education	51 **I.**	5		Dairying 76	4		
Animal Husbandry	50 **I.**	3					
Animal Husbandry	81 **II.**	1	**II.**	Dairying 51	2	Agricultural Economics 75[1]	5
Chemistry	25 **I.**	3		Dairying 77	5	Agricultural Economics 76	5
Chemistry	61 **I.**	5		Economic Sociology 51[1]	5	Animal Husbandry 81	1
Chemistry	81 **II.**	5		Microbiology 51	5	Chemistry 81	5
Dairying	50 **I.**	5		Rural Sociology 51[1]	3	Dairying 77	5
Dairying	51 **II.**	2		Veterinary Science 50[1]	5	Farm Management 51[1]	3
Dairying	52 **III.**	5					
Dairying	75 **I.**	3	**III.**	Dairying 52	5	Agricultural Economics 53	5
Dairying	76 **I.**	4		Dairying 78	5	Agricultural Economics 84[1]	2
Dairying	77 **II.**	5		Economic Sociology 52[1]	5	Dairying 78	5
Dairying	78 **III.**	5		Rural Engineering 81[1]	4		
Economic Sociology[1]	51 **II.**	5					
Economic Sociology[1]	52 **III.**	5					
Farm Management[1]	51 **II.**	3					
Microbiology	51 **II.**	5					
Microbiology	82 **I.**	5					
Rural Engineering[1]	81 **III.**	4					
Rural Sociology[1]	51 **II.**	3					
Veterinary Science[1]	50 **II.**	5					
		105[2]					

[1] Suggested, but not required. [2] Only 60 credit-hours required.

Farm Management. (Major.)

Professor James A. Foord, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agronomy	50 **I.**	3	**I.**	Agronomy 50	3	Animal Husbandry 75[1]	3
Agronomy[1]	51 **III.**	3		Animal Husbandry 50	3	Farm Management 76	3
Agronomy	77 **II.**	5		Dairying 50	5	Rural Engineering 75	5
Animal Husbandry	50 **I.**	3		Pomology 50	3	Veterinary 75	5
Animal Husbandry	51 **II.**	3					
Animal Husbandry[1]	52 **III.**	3					
Animal Husbandry	53 **III.**	5	**II.**	Animal Husbandry 51	3	Agronomy 77	5
Animal Husbandry[1]	75 **I.**	3		Farm Management 51	3	Animal Husbandry 76[1]	3
Animal Husbandry[1]	76 **II.**	3		Pomology 51	3	Farm Management 78	1
Animal Husbandry	77 **III.**	3				Rural Engineering 78	5
Dairying	50 **I.**	5					
Dairying[1]	52 **III.**	5					
Farm Management	51 **II.**	3	**III.**	Agronomy 51[1]	3	Agronomy 51[1]	3
Farm Management	76 **I.**	3		Animal Husbandry 52[1]	3	Animal Husbandry 77	3
Farm Management	77 **III**	3		Animal Husbandry 53	5	Farm Management 77	3
Farm Management	78 **II.**	1		Dairying 52[1]	5	Farm Management 79	1
Farm Management	79 **III.**	1		Forestry 58	3	Farm Management 81[1]	2
Farm Management[1]	81 **III.**	2				Pomology 78[1]	3
Forestry	58 **III.**	3				Poultry 78[1]	5
Pomology	50 **I.**	3				Rural Engineering 79	5
Pomology	51 **II.**	3					
Pomology[1]	78 **III.**	3					
Poultry[1]	78 **III.**	5					
Rural Engineering	75 **I.**	5					
Rural Engineering	78 **II.**	5					
Rural Engineering	79 **III.**	5					
Veterinary	75 **I.**	5					
		94[2]					

[1] Suggested, but not required. [2] Only 60 credit-hours required.

Poultry Husbandry. (Major.)

Professor John C. Graham, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics	53 **III.**	5	**I.**	Agronomy 50	3	Poultry 75	3
Agronomy	50 **I.**	3		Animal Husbandry 50	3	Poultry 76	4
Animal Husbandry	50 **I.**	3		Poultry 50	5	Veterinary 85	3
Farm Management	51 **II.**	3					
Poultry Husbandry	50 **I.**	5	**II.**	Poultry 51	5	Farm Management 51	3
Poultry Husbandry	51 **II.**	5				Poultry 77	5
Poultry Husbandry	52 **III.**	5				Veterinary 86	3
Poultry Husbandry	75 **I.**	3					
Poultry Husbandry	76 **I.**	4	**III.**	Agricultural Economics 53	5	Poultry 79	4
Poultry Husbandry	77 **II.**	5		Poultry 52	5	Veterinary 87	3
Poultry Husbandry	79 **III.**	4					
Veterinary Science	85 **I.**	3					
Veterinary Science	86 **II.**	3					
Veterinary Science	87 **III.**	3					
		54					

Strongly Advised. — Microbiology 50 I, Zoölogy 76 II.

Floriculture.

Professor Clark L. Thayer, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Botany	50 **I.**	2	**I.**	Botany 50	2	Floriculture 75	3
Botany	51 **II.**	2		Floriculture 50	4	Horticulture 50	5
Floriculture	50 **I.**	4		Floriculture 53	4		
Floriculture	51 **II.**	4					
Floriculture	52 **III.**	4	**II.**	Botany 51	2	Floriculture 76	3
Floriculture	53 **I.**	4		Floriculture 51	4	Floriculture 79	3
Floriculture	55 **III.**	3					
Floriculture	75 **I.**	3	**III.**	Floriculture 52	4	Floriculture 77	3
Floriculture	76 **II.**	3		Floriculture 55	3	Floriculture 80	2–3
Floriculture	77 **III.**	3				Horticulture 51	5
Floriculture	79 **II.**	3					
Floriculture	80 **III.**	2–3					
Horticulture	50 **I.**	5					
Horticulture	51 **III.**	5					
		47–48					

Advised. — The department advises all students who major in this subject to take Entomology 50, Landscape Gardening 75, Botany 78, 79 and 80, and Agricultural Economics 53 and 83.

Landscape Gardening. (Major.)

Professor Frank A. Waugh, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Floriculture	55 **III.**	3	**I.**	Horticulture 50	5	Landscape Gardening 75	3
Horticulture	50 **I.**	5		Landscape Gardening 50	5	Landscape Gardening 76	4
Horticulture	51 **III.**	5		Landscape Gardening 78		Landscape Gardening 78	
Landscape Gardening	50 **I.**	5		or 79	3	or 79	3
Landscape Gardening	51 **II.**	4					
Landscape Gardening	52 **III.**	5	**II.**	Landscape Gardening 51	4	Landscape Gardening 80	4
Landscape Gardening	75 **I.**	3				Landscape Gardening 81	4
Landscape Gardening	76 **I.**	4					
Landscape Gardening	77 **III.**	4					
Landscape Gardening	78 **I.**	3	**III.**	Floriculture 55	3	Landscape Gardening 77	4
Landscape Gardening	79 **I.**	3		Horticulture 51	5	Landscape Gardening 82	4
Landscape Gardening	80 **II.**	4		Landscape Gardening 52	5		
Landscape Gardening	81 **II.**	4					
Landscape Gardening	82 **III.**	4					
		56					

Additional Information. — Modifications may be permitted when they appear advisable.

Pomology. (Major.)

Professor Fred C. Sears, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics	53 **III.**	5	**I.**	Botany 50	2–6	Horticultural Manuf. 75	5
Agronomy	77 **II.**	5		Pomology 50	3	Pomology 75	3
Botany	50 **I.**	2–6				Pomology 77	3
Horticultural Manufactures	75 **I.**	5				Pomology 80	1
Horticultural Manufactures	76 **II.**	3					
Pomology	50 **I.**	3	**II.**	Pomology 51	3	Agronomy 77	5
Pomology	51 **II.**	3		Pomology 54	3	Horticultural Manuf. 76	3
Pomology	52 **III.**	3				Pomology 76	3
Pomology	54 **II.**	3				Pomology 81	1
Pomology	75 **I.**	3					
Pomology	76 **II.**	3	**III.**	Agricultural Economics 53	5	Pomology 78	3
Pomology	77 **I.**	3		Pomology 52	3	Pomology 82	1
Pomology	78 **III.**	3				Rural Engineering 78	5
Pomology	80 **I.**	1					
Pomology	81 **II.**	1					
Pomology	82 **III.**	1					
Rural Engineering	78 **III.**	5					
		52–58					

Vegetable Gardening. (Major.)

Professor Frank A. Waugh, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agronomy	75 **I.**	5	**I.**	Agronomy 75	5	Agronomy 75	5
Agronomy	77 **II.**	5		Botany 50	2	Vegetable Gardening 75	5
Botany	50 **I.**	2					
Botany	51 **II.**	2	**II.**	Agronomy 77	5	Vegetable Gardening 76	5
Vegetable Gardening	52 **II.**	5		Botany 51	2		
Vegetable Gardening	53 **III.**	5		Vegetable Gardening 52	5		
Vegetable Gardening	75 **I.**	5					
Vegetable Gardening	76 **II.**	5	**III.**	Vegetable Gardening 53	5	Vegetable Gardening 77	5
Vegetable Gardening	77 **III.**	5					
		39					

Economic Botany. (Major.)

Professor A. Vincent Osmun, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agricultural Education	56 **III.**	5	**I.**	Agronomy 50	3	Botany 58 or 61	3
Agronomy	50 **I.**	3		Botany 52 or	3	Botany 75 or	5
Botany	52 **I.**	3		Botany 58 or 61	3	Botany 78	5
Botany	53 **II.**	3		Chemistry 51	6	Chemistry 80	5
Botany	54 **III.**	3		English 65	3		
Botany	55 **III.**	5		French or German 50	3		
Botany	58 **I.**	3					
Botany	61 **I.**	3					
Botany	59 **II.**	3	**II.**	Botany 53 or	3	Botany 59 or 62	3
Botany	62 **II.**	3		Botany 59 or 62	3	Botany 76 or	5
Botany	60 **III.**	3		Chemistry 52	6	Botany 79	3 or 5
Botany	63 **III.**	3		Entomology 51	3	Chemistry 86	3
Botany	75 **I.**	5		French or German 51	3	Entomology 90	3
Botany	76 **II.**	5					
Botany	77 **III.**	5	**III.**	Agricultural Education 56	5	Botany 60 or 63	3
Botany	78 **I.**	5		or		Botany 77 or	5
Botany	79 **II.**	3 or 5		English 52	3	Botany 80	3 or 5
Botany	80 **III.**	3 or 5		Botany 54 or	3	Agricultural Education 56	5
Chemistry	51 **I.**	6		Botany 60 or 63	3		
Chemistry	52 **II.**	6		Botany 55	5		
Chemistry	80 **I.**	5		French or German 52	3		
Chemistry	86 **II.**	3		Geology 52	5		
English	52 **III.**	3					
English	65 **I.**	3					
Entomology	51 **II.**	3					
Entomology	90 **II.**	3					
French or German	50 **I.**	3					
French or German	51 **II.**	3					
French or German	52 **III.**	3					
Geology	52 **III.**	5					
		112-116[1]					

[1] A student is required to select, in consultation with his major adviser, at least 60 credits from this list.

Agricultural Chemistry. (Major.)

Professor Charles A. Peters, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Chemistry	51 **I.**	6	**I.**	Chemistry 51	6	Chemistry 75	6
Chemistry	52 **II.**	6		Chemistry 61	5	Chemistry 80	5
Chemistry	53 **III.**	6	**II.**	Chemistry 52	6	Chemistry 86	3
Chemistry	61 **I.**	5		Chemistry 62	6	Chemistry 90, 92, 94, 96	5
Chemistry	62 **II.**	6	**III.**	Chemistry 53	6	Chemistry 87	3
Chemistry	63 **III.**	5		Chemistry 63	5	Chemistry 91, 93, 95, 97	5
Chemistry	75 **I.**	6					
Chemistry	80 **I.**	5					
Chemistry	86 **II.**	3					
Chemistry	87 **III.**	3					
Chemistry	90 **II.**						
Chemistry	92 **II.**	5[1]					
Chemistry	94 **II.**						
Chemistry	96 **II.**						
Chemistry	91 **III.**						
Chemistry	93 **III.**	5[1]					
Chemistry	95 **III.**						
Chemistry	97 **III.**						
		61					

A knowledge of German is required. Students having had no German previously should elect it at the beginning of the sophomore year.

[1] Students will select one course from groups 90, 92, 94, 96, and 91, 93, 95, 97, respectively.

Economic Entomology. (Major.)

Professor Henry T. Fernald, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Botany	51 **II.**	4	**I.**	Chemistry 51[1]	6	Chemistry 80	5
Chemistry	80 **I.**	5		Entomology 52	2	Entomology 76	5
Entomology	52 **I.**	2		Entomology 53	5	Entomology 85	3
Entomology	53 **I.**	5		Entomology 54	2	Horticulture 50[1]	5
Entomology	54 **I.**	2		French or German 50[1]	3	Zoölogy 50	3
Entomology	55 **II.**	4	**II.**	Botany 51	4	Entomology 77	3
Entomology	56 **II.**	3		Chemistry 52[1]	6	Entomology 90	3
Entomology	57 **III.**	2		Entomology 55	4	Pomology 79[1]	3
Entomology	65 **III.**	3		Entomology 56	3	Zoölogy 51	3
Entomology	75 **III.**	4		French or German 51[1]	3		
Entomology	76 **I.**	5	**III.**	Entomology 57	2	Entomology 78	4
Entomology	77 **II.**	3		Entomology 65	3	Geology 52	5
Entomology	78 **III.**	4		Entomology 75	4	Horticulture 51[1]	5
Entomology	85 **I.**	3		Chemistry 53[1]	6	Pomology 78[1]	3
Entomology	90 **II.**	3		French or German 52[1]	3	Zoölogy 52	3
Geology	52 **III.**	5					
Zoölogy	50 **I.**	3					
Zoölogy	51 **II.**	3					
Zoölogy	52 **III.**	3					
		66					

[1] Suggested, but not required.

Microbiology. (Major.)

Professor Charles E. Marshall, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.
Microbiology	50 **I.**	
or		
Microbiology	50 **II.**	
or		
Microbiology	50 **III.**	5
Microbiology	51 **II.**	
or		
Microbiology	51 **III.**	5
Microbiology	52 **III.**	5
Microbiology	60 **I.**	3
Microbiology	61 **II.**	3
Microbiology	62 **III.**	3
Microbiology	81 **I.**	
or		
Microbiology	82 **I.**	
or		
Microbiology	83 **III.**	5
Microbiology	80 **II.**	
or		
Microbiology	75 **II.**	5
Microbiology	76 **III.**	5
		39

Term.	Junior.	Credit.	Senior.	Credit.
I.	Microbiology 50	5	Microbiology 60	3
	Microbiology 60	3	Microbiology 81	5
			Microbiology 82	5
II.	Microbiology 50	5	Microbiology 61	3
	Microbiology 51	5	Microbiology 75	5
	Microbiology 61	3	Microbiology 80	5
III.	Microbiology 50	5	Microbiology 62	3
	Microbiology 51	5	Microbiology 76	5
	Microbiology 52	5	Microbiology 83	5
	Microbiology 62	3		

Agricultural Economics. (Major.)

Professor Alexander E. Cance, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.
Agricultural Economics	50 **I.**	5
Agricultural Economics	52 **II.**	5
Agricultural Economics	53 **III.**	5
Agricultural Economics	75 **II.**	5
Agricultural Economics	76 **II.**	5
Agricultural Economics	77 **I.**	5
Agricultural Economics	78 **III.**	3
Agricultural Economics	79 **I.**	5
Agricultural Economics	87 **III.**	3
Agricultural Education	55 **I.**	5
Economic Sociology	51 **II.**	5
Economic Sociology	52 **III.**	5
English	65 **I.**	3
Rural Sociology[1]	51 **II.**	3
Rural Sociology[1]	52 **III.**	3
		65[2]

Term.	Junior.	Credit.	Senior.	Credit.
I.	Agricultural Economics 50	5	Agricultural Economics 77	5
	Agricultural Education 55	5	Agricultural Economics 79	5
	English 65	3		
II.	Agricultural Economics 52	5	Agricultural Economics 75	5
	Economic Sociology 51	5	Agricultural Economics 76	5
	Rural Sociology 51[1]	3		
III.	Agricultural Economics 53	5	Agricultural Economics 78	3
	Economic Sociology 52	5	Agricultural Economics 87	3
	Rural Sociology 52[1]	3		

[1] Suggested, but not required.

[2] Only 60 credit-hours required.

Agricultural Education. (Major.)

Professor Winthrop S. Welles, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agricultural Education	51 **I.**		**I.**	Agricultural Economics 50	5	Agricultural Education 76	5
or				Agricultural Education 55	5	Agricultural Education 80	1–5
Agricultural Education	51 **II.**	5					
Agricultural Education	52 **I.**	5	**II.**	Agricultural Economics 75	5	Agricultural Education 75	3
Agricultural Education	55 **I.**			Agricultural Education 51	5	Agricultural Education 80	1–5
or							
Agricultural Education	55 **II.**	5	**III.**	Agricultural Economics 53	5	Agricultural Education 77	3
Agricultural Education	56 **II.**			Agricultural Education 56	5	Agricultural Education 80	1–5
or							
Agricultural Education	56 **III.**	5					
Agricultural Education	75 **II.**	3					
Agricultural Education	76 **I.**						
or							
Agricultural Education	76 **III.**	5					
Agricultural Education	77 **III.**	3					
Agricultural Education	79 **III.**	3					
Agricultural Education	80 **I.**						
or							
Agricultural Education	80 **II.**						
or							
Agricultural Education	80 **III.**	1–5					
Agricultural Education	81 **III.**	2					
Agricultural Education	83 **III.**	2					
Agricultural Education	85 **I.**	3					
Agricultural Education	95 **II.**	3					
		45–49					

Courses indicated for juniors and seniors are planned for students preparing to teach agriculture. Technical courses in agricultural and additional supporting courses are chosen in conference with the adviser.

Advised. — (*a*) For general teaching program, six of the following courses: 51, 52, 55, 56, 75, 79, 80 and 95. (*b*) For extension teaching 51, 55, 76, 77 and 80 or their equivalents.

Rural Sociology. (Major.)

Professor —— ——, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agricultural Economics	50 **I.**	5	**I.**	Economic Sociology 50	5	Agricultural Economics 50	5
Agricultural Economics	52 **II.**	5		Rural Sociology 50	3	Economic Sociology 75	5
Agricultural Economics	53 **III.**	5				Rural Sociology 79	1–3
Agricultural Economics	75 **II.**	5					
Economics and Sociology	50 **I.**	5	**II.**	Economic Sociology 51	5	Agricultural Economics 52	5
Economics and Sociology	51 **II.**	5		Rural Sociology 51	3	Agricultural Economics 75	5
Economics and Sociology	52 **III.**	5				Rural Sociology 77	3
Economics and Sociology	75 **I.**	5				Rural Sociology 80	1–3
Rural Sociology	50 **I.**	3					
Rural Sociology	51 **II.**	3	**III.**	Economic Sociology 52	5	Agricultural Economics 53	5
Rural Sociology	52 **III.**	3		Rural Sociology 52	3	Rural Sociology 81	1–3
Rural Sociology	77 **II.**	3					
Rural Sociology	79 **I.**	1–3					
Rural Sociology	80 **II.**	1–3					
Rural Sociology	81 **III.**	1–3					
		55–61[1]					

[1] Only 60 credit-hours required.

Rural Home Life. (Major.)

Professor Edna L. Skinner, *Adviser.*

[The heavy-faced type indicates the term in which the course is given.]

Course.	Number.	Credit.	Term.	Junior.	Credit.	Senior.	Credit.
Agricultural Education	55 **II.**	5	**I.**	Chemistry 80	5	Horticultural Manuf. 80	4
Chemistry	80 **I.**	5		Economic Sociology 50	5	Rural Home Life 76	4
Economic Sociology	50 **I.**	5		Rural Home Life 50	5	Rural Home Life 81	3
History and Government	27 **III.**	2					
Horticultural Manufactures	80 **I.**	4	**II.**	Agricultural Education 55	5	Rural Home Life 78	3
Rural Engineering	53 **II.**	4		Rural Engineering 53	4		
Rural Home Life	50 **I.**	5					
Rural Home Life	52 **III.**	5	**III.**	History and Government 27	2	Rural Home Life 83	3
Rural Home Life	61 **III.**	3		Rural Home Life 52	5		
Rural Home Life	76 **I.**	4		Rural Home Life 61	3		
Rural Home Life	78 **II.**	3					
Rural Home Life	81 **I.**	3					
Rural Home Life	83 **III.**	3					
		51					

Description of Courses.

DIVISION OF AGRICULTURE.

Professor Foord.

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Agriculture.

1. **I.** 2. **II.** 3. **III.** Agriculture. — Required course for all freshmen. A survey course, tracing the development of man as influenced by agriculture. It considers those problems which our complicated, present-day civilization looks to agriculture to solve, — problems practical, scientific, commercial, sociological. The object of the course is to give to students the agricultural concept, and an appreciation of the close relationship of all lines of human activity to the great problems of agriculture.
3 class hours. Credit, 3.
Assistant Professor Lanphear.

6. **III.** Agricultural Opportunities for Women. — For freshman women. Designed to show the woman who is interested in agriculture what opportunities there are for her in that field, and how she may best take advantage of them. The types of agricultural work for which women are best adapted are discussed. A study is made of some of the special problems which confront the woman farmer, and her best ways of solving them.
2 class hours. Credit, 2.
Miss Hamlin.

Agronomy.

Professor Beaumont, Assistant Professor Michels, Assistant Professor Lanphear, Mr. Thayer, Mr. Street.

The courses in agronomy are designed to present the fundamental knowledge concerning the soil and the principal products of the field. The basic course in soils is required of students majoring in the agriculture, horticulture, and rural social science divisions. The electives are designed to meet the needs of those specializing in soils and field crops and other specialized fields including both pure and applied science.

The laboratories for soils and fertilizers include one for elementary work, supplied with locker equipment for 200 students, and one for advanced work, accommodating 80 students. These laboratories are equipped with steam and electric ovens, balances, centrifuge, microscopes and other apparatus necessary for a study of soils and fertilizers. Storerooms, stock rooms, and balance rooms are conveniently near the laboratories. There is also a workroom attached, equipped with power machinery for grinding soils, fodders and the like.

The crops' laboratories include one for seed study, with lockers for 50 students, and a laboratory for the study of cereals, forage crops, roots, etc., with lockers for 64 students. The equipment of these laboratories includes steam ovens, constant temperature electric ovens, ovens for seed germination, Brown-Duval moisture apparatus, balances, microscopes, and collections of seeds, grasses, tubers, weeds, etc. A balance room, root cellar and two storerooms, one of which is mouse-proof, are also used for crop work.

A modern steam-heated greenhouse 25 by 35 feet, used for work in soils and crops, is a valuable part of the equipment. Near the greenhouse is a crop garden on which different varieties of corn, grasses, clovers, etc., are grown for demonstration purposes, and as a source of material for class work. In addition, the general college farm of 250 acres is used for field study in soils and crops, and as a source of material.

Required Courses.

25. **I.** Agronomy. — For sophomores. An introductory course designed to acquaint the student with the most important field crops and their production.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Assistant Professor Michels and the Department.

27. **III.** Soils and Fertilizers. — For sophomores. A study of soils and their properties, soil management, methods of soil improvement and maintenance of fertility, including the use of farm manures, commercial fertilizers and soil amendments.
3 class hours. 1 2-hour laboratory period, credit, 4.
Professor Beaumont and the Department.
Prerequisite, Freshman-required Chemistry.

Elective Courses.

50. **I.** Forage Crops. — For juniors; seniors may elect. History, classification and production of corn and of those grasses, legumes, root and tuber crops suited to New England conditions. Crops of less importance in New England are briefly considered. The work includes lecture, laboratory and field study.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Michels.
Prerequisites, Agronomy 25 and 27, Botany 3.

51. **III.** Advanced Field Crops (1926–27). — For juniors and seniors. Study of the cereals and other field crops not taken up or only briefly considered in Course 50. General problems of crop production are also considered, and the work is not entirely confined to New England conditions. The laboratory work includes a study of the cereals, the quality of seeds, grains and crop products, crop problems and field work with such crops as are available. Given in alternate years.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Michels.
Prerequisite, Agronomy 50.

75. **I.** Advanced Soils (1925–26). — For juniors and seniors. A continuation of studies begun in Agronomy 27 with special emphasis placed on soil classification and adaptability and recent advances in soil science. The field work consists of a detailed study of soil texture and other properties affecting crop adaptability and soil management; accompanied by a laboratory study of the physical properties of the soils sampled. Given in alternate years.
2 class hours. 1 4-hour and 1 2-hour laboratory period, credit, 5.
Professor Beaumont.
Prerequisite, Agronomy 27.

77. **II.** Manures and Fertilizers. — For seniors. An advanced course, giving a general discussion of the different theories which have been held relative to the functions and importance of manures and fertilizers, and leading up to the views at present accepted. Considerable attention is devoted to consideration of the experimental work which has been done, and which is now in progress. The laboratory work consists of a study of fertilizers, fertilizer mixtures, limes and culture work.
3 class hours. 2 2-hour laboratory periods, credit 5.
Professor Beaumont and the Department.
Prerequisite, Agronomy 27. Advised, Chemistry 61.

78. **II.** Breeding of Field Crops (1925–26). — For juniors and seniors. Deals with the improvement, by selection and breeding, of the crops studied in Course 50. Given in alternate years.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Michels.

Prerequisite, Agronomy 50.

Animal Husbandry.

Professor ——, Assistant Professor Rice, Assistant Professor Glatfelter, Mr. ———

It is the purpose of this department to present comprehensive information on the subject of animal husbandry. The first courses are studies of the breeds, types and market classes of live stock. These are followed by courses in judging, breeding and management.

The department is equipped with an excellent laboratory, Grinnell Arena, which has a seating capacity of 180. The equipment for classroom instruction includes upwards of 125 head of dairy cattle which are superior representatives of Jersey, Guernsey, Ayrshire and Holstein breeds; considerable numbers of Berkshire and Chester White pigs; pure-bred Percherons; and several work teams of various types. The department has a collection of plaster of Paris models of individuals of foreign and domestic breeds of horses, cattle, sheep and swine; and a set of over 250 lantern slides portraying the leading prize-winning producing and breeding animals of the principal breeds of horses, cattle, sheep and swine. There is also a collection of the different foodstuffs available for the use of New England farmers. All this equipment is being added to from time to time as funds are available.

Required Courses.

25. **I.** Livestock Judging and Market Classes of Farm Animals. — For sophomores. A study of the principles governing the selection of animals for market, feed lot, breeding, milk production and work, including the use of the score card and the comparative judging of the various types of live stock. Textbook, Vaughn's "Types and Market Classes of Farm Animals."
2 class hours. 1 2-hour laboratory period, credit, 3.
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26. **II.** Types and Breeds of Livestock. — For sophomores. A course covering the origin, history, development and characteristics of the different breeds of horses and sheep. Textbook, Plumb's "Types and Breeds of Farm Animals."
2 class hours. 1 2-hour laboratory period, credit, 3.
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Prerequisite, Animal Husbandry 25.

Elective Courses.

50. **I.** Feeds and Feeding. — For juniors. A study of the principles of animal nutrition; of the composition and qualities of feeding materials. Textbook, Henry's "Feeds and Feeding."
3 class hours. Credit, 3.
Assistant Professor Rice.

Prerequisite, Animal Husbandry 25 and 26.

51. **II.** Feeds and Feeding. — For juniors. A study of feeding practice as related to all farm animals. Considerable work will be given in the formulating of rations.
3 class hours. Credit, 3.
Assistant Professor Rice.

Prerequisite, Animal Husbandry 50.

52. **III.** Advanced Stock Judging. — For juniors; seniors may elect. Designed to equip students in the judging of classes of different types of live stock;

to strengthen them in the selection of superior sires; and equip them for stock judging at fairs. Visits are made to the best herds for the various breeds of stock in the State. Judging teams to represent the college will be selected from this class.
1 2-hour and 1 4-hour laboratory period, credit, 3.
Assistant Professor RICE.
Prerequisites, Animal Husbandry 25 and 26.

53. **III.** PRINCIPLES OF BREEDING. — For juniors; seniors may elect. Designed to familiarize students with the problems that are involved in animal improvement; to acquaint them with the facts which are already established; to scrutinize prevailing theories; and to indicate the lines and methods of further work. Some of the subjects studied are: variations, their causes and heritability; DeVrie's theory of mutations; the inheritance of acquired characters; the pure line; Mendelian law; the making of new types; the determination of sex; applications to human heredity. A few periods at the end of the course are devoted especially to the application of principles in live-stock improvement. Supplementary reading.
5 class hours. Credit, 5.
Assistant Professor RICE.
Prerequisites, Animal Husbandry 25, 26, Zoölogy 26.

75. **I.** BEEF AND SWINE PRODUCTION. — For seniors. A study of the leading breeds of beef cattle and swine, together with the work of some of the most successful breeders. Considerable time will be given also to the production of commercial beef and pork. In this course such live-stock management problems as apply to beef cattle and swine will be included.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor RICE.
Prerequisites, Animal Husbandry 51, 52 and 53.

76. **II.** HORSE AND SHEEP PRODUCTION. — For seniors. A study of the production of these animals planned in the same manner as that of the previous course.
2 lectures. 1 2-hour laboratory period, credit, 3.
Assistant Professor GLATFELTER.
Prerequisites, Animal Husbandry 51, 52 and 53.

77. **III.** DAIRY CATTLE AND MILK PRODUCTION. — For seniors. A study of the leading breeds of dairy cattle, the most successful breeders and famous breeding animals, advance registry testing and feeding for production, sales methods and advertising.
2 lectures. 1 2-hour laboratory period, credit, 3.

Prerequisites, Animal Husbandry 51, 52 and 53.

81. **II.** DAIRY AND ANIMAL HUSBANDRY. — For seniors. Seminar for seniors majoring in dairying and animal husbandry.
1 class hour. Credit, 1.
DEPARTMENTS OF DAIRYING AND ANIMAL HUSBANDRY.

Dairying.

Professor JUDKINS, Assistant Professor YAXIS, Mr. PENDLETON, Mr. SMITH.[1]

The dairy manufactures building is new, well lighted and of sanitary construction. It is designed and equipped especially for teaching dairy manufactures. The equipment includes all kinds of machinery that are considered essential to the proper handling of milk and the making of cream, butter, ice cream and soft cheeses.

Course 50 is for students who desire a general idea of dairy work and manu-

[1] Absent on leave.

facturing processes. Some of the courses are arranged to give instruction in general dairy work as associated with Massachusetts agriculture; some are arranged to give to a smaller group of students more complete work in dairy manufactures. Those majoring in dairy manufactures should have at least one summer's experience in a commercial plant before graduation.

50. **I.** General Dairying. — For juniors; seniors may elect. A general course, prerequisite to all other dairy courses, except course 51, and for those who wish to take only one course in dairying to get a general knowledge of the subject. The work covers briefly a study of milk, its secretion, composition and various tests applied thereto; proper methods of handling milk and cream; the use of separators; elements of butter making, cheese making and ice cream making.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Judkins.

51. **II.** Judging Dairy Products. — For juniors. The judging of milk, cheese, butter and ice cream according to standard methods. A team is chosen from this class to represent the college in the dairy products judging contests held at the Eastern States Exposition and at the National Dairy Show.
2 2-hour laboratory periods, credit, 2.
Professor Judkins.

52. **III.** Market Milk. — For juniors; seniors may elect. A study of the various phases of the market milk industry, sanitary production; transportation; marketing; handling in the city plant; delivery systems; milk and its relation to the public health; inspection; milk laws; food value and advertising. Some milk plants will be visited.
3 class hours. 1 4-hour laboratory period, credit, 5.
Professor Judkins and Mr. Smith.
Prerequisite, Dairy 50.

75. **I.** Milk Products (1925–26). — For juniors and seniors. The manufacture of milk products other than butter and ice cream, including cheddar cheese, soft and fancy cheese, condensed and powdered milk, casein, commercial buttermilk, etc. Laboratory exercise largely in cheese making and commercial buttermilk manufacture. Given in alternate years.
1 class hour. 1 4-hour laboratory period, credit, 3.
Assistant Professor Yaxis.
Prerequisite, Dairy 50, previously or in conjunction.

76. **I.** Advanced Testing (1926–27). — For juniors and seniors. Work covers moisture and fat testing for all dairy products; the casein test; salt test for butter; acid tests; work with the Mojonnier apparatus and many other applied chemical tests used in dairy manufacture work. Given in alternate years.
2 4-hour laboratory periods, credit, 4.
Mr. Pendleton.
Prerequisite, Dairy 50, previously or in conjunction.

Elective Courses.

77. **II.** Butter Making (1925–26). — For juniors and seniors. A study of separators and cream separation; handling milk and cream for butter making; preparation of starters, and ripening cream; churning; markets and their requirements; marketing, scoring and judging butter; management; butter making machinery and care thereof; problems. Given in alternate years.
2 class hours. 2 3-hour laboratory periods, credit, 5.
Assistant Professor Yaxis.
Prerequisite, Dairying 50.

78. **III.** Ice Cream Making (1926–27). — For juniors and seniors. A study of the principles and practice of ice cream making. Laboratory equipment is

modern and the laboratory instruction will cover commercial practices. Some ice cream plants will be visited. Given in alternate years.

2 class hours. 2 3-hour laboratory periods, credit, 5.

Professor JUDKINS and Mr. PENDLETON.

Prerequisite, Dairying 50.

Farm Management.

Professor FOORD, Assistant Professor ABELL.

The purpose of the courses in this department is to present various considerations of farming as a business. This involves a knowledge of the cost of production and the profit from the different enterprises such as dairy, poultry or orchard; a study of the enterprises, and the relative amounts of each that will give the best use of labor and equipment on the farm under consideration.

The college farm of 250 acres is under the general supervision of the Department of Farm Management, and furnishes demonstration material. It includes improved land, pasture land and a farm woodlot. The improved land illustrates the value of good culture and the best known methods for the maintenance of fertility. The farm is equipped with suitable buildings and good machinery for the work carried on, of which the production of certified milk is an important branch. Several good farms in the vicinity, illustrating types of both special and general agriculture, may be inspected and studied. The offices of the department are in Stockbridge Hall.

Elective Courses.

51. **II.** FARM ACCOUNTS AND COST ACCOUNTING. — For juniors; seniors may elect. A study of farm inventories, single-enterprise accounts, complete farm accounts and farm records. Special emphasis is given to the interpretation of results and their application in the organization and management of the farm.

3 2-hour laboratory periods, credit, 3.

Professor FOORD.

76. **I.** FARM MANAGEMENT. — For seniors; juniors may elect. A study of farming as a business; regions and types of farming; the general principles of farm management and the influence of size, production, live stock and crop farming on the farmer's labor income; arrangement of fields and buildings; use of land, capital and labor; choosing and buying a farm.

2 class hours. 1 2-hour laboratory period, credit, 3.

Professor FOORD.

Prerequisites, Agronomy 50, Animal Husbandry 25 and 26, and some farm experience.

77. **III.** FARM MANAGEMENT. — For seniors; juniors may elect. A further and more specific study of the principles and practices as outlined in Course 76, with reference to their application to different regions of the United States and especially to New England. Trips to successful farms are a required part of the course.

1 class hour. 1 4-hour laboratory period, credit, 3.

Professors FOORD and ABELL.

Prerequisites, Farm Management 51 and 76.

78. **II.** SEMINAR. — For seniors majoring in general agriculture; others by arrangement.

1 class hour. Credit, 1.

Professors FOORD and ABELL.

79. **III.** SEMINAR. — For seniors majoring in general agriculture; others by arrangement.

1 class hour. Credit, 1.

Professors FOORD and ABELL.

81. **III.** Farming in the United States. — For seniors. A study of the agricultural regions of the United States and the different types and methods of farming carried on in each. The economic reasons for the establishment and maintenance of each type will be considered.

2 2-hour laboratory periods, credit, 2.
The Department.

Prerequisite. Farm Management 76.

Poultry Husbandry.

Professor Graham, Professor Sanctuary, Assistant Professor Banta, Miss Pulley.

The introductory courses (50, 51, 52) give a knowledge of the general routine of elementary poultry keeping. The advanced studies prepare men for the successful operation of poultry plants, either as owners or managers. Graduate work, preparation for further teaching, extension or investigation.

The poultry plant consists of 8 acres of land sloping gently to the west. The buildings consist of three incubator cellars equipped with a number of lamp incubators and two mammoth machines with a total capacity of 9,000 eggs; a pipe brooder house (open pipe system) and 40 colony brooder houses which give a brooding capacity for 7,000 chicks, the equipment for these houses including a large variety of coal-stove brooders and kerosene hovers; a long laying house 14 by 180 feet, which accommodates 500 layers, furnishing facilities for student work in pen management, utility and fancy judging, etc.; and a laboratory 14 by 80, for killing, picking, drawing, trussing, packing, crate fattening and cramming. The fattening equipment consists of a modern sanitary all-steel battery with 16 compartments and 10 wooden crates, accommodating, altogether, 350 birds. There are also a storage building, 28 to 64 feet, for root cellar, poultry carpentry, poultry mechanics, feed room and storage; an experimental breeding house, 18 by 60; a combination laying, testing and breeding house, 18 by 72, for experimental purposes; a model laying house, 18 by 30, for 100 hens, and a house 20 by 40, for 200 hens. The six old experiment-station houses, each 12 by 18 feet, are used as special mating and overflow pens. The total capacity for laying hens is 1,600. A manure shed 14 by 18 feet; an oil and tool house 10 by 12; an incinerator 10 by 10; and two backyard model poultry houses 8 by 10 and 8 by 8 give a total of 76 buildings, not including a pheasant run, 16 roosting sheds 10 by 10, and numerous small coops for natural incubation and brooding.

Elective Courses.

50. **I.** Judging and Culling. — For juniors; seniors may elect. A study of the origin and evolution of our standard breeds and varieties. Judging for production quality, using trap-nested birds; culling the flock; judging exhibition quality by score card and comparison. Several farms will be visited, also several of the leading Connecticut Valley Poultry Shows. Poultry Judging Teams competing in the Intercollegiate Contest at Madison Square Garden are trained in this course.

2 class hours. 2 3-hour laboratory periods, credit, 5.
Assistant Professor Banta.

51. **II.** Poultry Feeds and Feeding. — For juniors; seniors may elect. A study of the principles and practices of poultry nutrition and their relationship to other poultry problems. An important part of the work will be the practical management of a pen of birds for a period of weeks, including observations and detailed record keeping.

3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor Banta.

52. **III.** Incubation, Brooding and Growing. — For juniors; seniors may elect. A study of the fundamental principles of incubation and rearing chicks;

also of modern equipment, including small and mammoth incubators and various types of brooding apparatus.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor SANCTUARY and Miss PULLEY.

75. **I.** POULTRY HOUSING AND SANITATION. — For seniors. A consideration of the biological and economic principles fundamental in the efficient designing, practical construction and equipping poultry farm buildings; also of external parasites and the insecticidal agents for their control.
3 class hours. Credit, 3.
Assistant Professor BANTA.

76. **I.** MARKET POULTRY AND POULTRY PRODUCTS. — For seniors. A study of the market classes of poultry, eggs and feathers, the requirements of different markets, methods of marketing, the cold storage of poultry and eggs. Preserving eggs, judging and scoring of live and dressed market poultry and market eggs are important features. Students are required to fatten pens of chickens by different methods and rations, keeping accurate data of the gains in weight and quality, also the costs of feed and labor, and resultant profit or loss. The annual market poultry show is staged under the direction of members of this class.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Professor GRAHAM and Miss PULLEY.

77. **II.** POULTRY BREEDING. — For seniors. A study of the principles of breeding and their application to poultry. Practice work in record keeping, pedigree hatching, stud and flock mating will be required as the season permits.
4 class hours. 1 2-hour laboratory period, credit, 5.
Professor SANCTUARY.

78. **III.** FARM POULTRY. — For seniors; juniors may elect. For those students who desire a general knowledge of poultry husbandry but who cannot devote more than one term to the subject; it is not intended for students specializing in poultry, and such students are admitted only by special permission. Emphasis is placed on the farm flock and its economic management. Utility classification, housing, culling, feeding, hatching, rearing, production, marketing and disease control receive special consideration.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor BANTA.

79. **III.** POULTRY FARM ORGANIZATION. — For seniors. A study of the organization of the poultry farm for greatest efficiency. The layout of fields and buildings, crop rotations, records, accounts and advertising will receive consideration. A trip covering two or three days will be made to representative successful poultry farms. The expense per student is approximately fifteen dollars. This is required of each student taking the course for credit.
3 class hours. 1 2-hour laboratory period, credit, 4.
Professor GRAHAM.

Prerequisite, Poultry 77.

Rural Engineering.

Professor GUNNESS, Assistant Professor MARKUSON, Mr. PUSHEE, Mr. NEWLON.

The courses in rural engineering are planned to give a working knowledge of those phases of engineering which apply directly to the farm. It is expected that the student will acquire a clear understanding of modern farm practice as it relates to permanent improvements of the farm and the farmstead, and in the selection and use of farm equipment.

This department has an office and the use of a lecture room in Stockbridge Hall. The work on farm structures is given in the large drawing room in the same building. This room is fitted with thirty drawing tables. Models and blue prints are available for the study of farm buildings. A set of post molds and a machine for making cement tile afford opportunity for practical work with cement.

The rural engineering shop is a one-story structure 100 by 126 feet. The carpenter shop in this building is fitted with benches fully equipped with tools for each student. The general repair shop is equipped with forges, benches, a drill press and grinders. The laboratory for farm machinery and farm motors is equipped with a complete line of field machines, gasoline engines, tractors and pumps. A complete assortment of engine accessories, consisting of carburetors, magnetos, etc., is available for thorough instruction in gas engines. A small dynamo and switchboard are used in the study of farm-lighting systems. The work on the small field machines is given in the basement of Stockbridge Hall, and the work on steam engines and steam heating is given in Flint Laboratory.

Required Courses.

27. **III.** Mechanical Drawing. — For sophomores; juniors and seniors may elect. Exercises are given in freehand lettering, geometric construction, orthographic projection and isometric drawing. Practice is given in inking, tracing and blueprinting.

2 2-hour laboratory periods, credit, 2.
The Department.

30. **III.** Shop Practice. — For sophomores; juniors and seniors may elect. Practice is given in the use of carpentry tools by exercises in bench work, repair of farm equipment and farm building construction. Exercises in forge work, pipe fitting, soldering, babbitting and fitting bearings, lining up shafting, lacing belts and splicing rope. Practice in the use of machinists' tools, such as file, cold chisel, drill press, lathe, taps and dies.

4 2-hour laboratory periods, credit, 4.
Mr. Pushee and Mr. Newlon.

33. **III.** Mechanics of the Household. — For sophomores. A study of mechanics in their relation to the household, including heat, light, electricity, the testing, care and maintenance of household equipment and appliances.

2 class hours. 2 2-hour laboratory periods, credit, 4.
The Department.

Elective Courses.

53. **II.** House Planning and Construction. — For juniors. A study of the common building materials and their use in house construction. The principles of house planning will be studied and plan designs originated, consideration being given to such problems as heating, lighting, water supply and sewage disposal. The economics of house building, including financing, maintenance and overhead expense, will also be studied.

2 class hours. 2 2-hour laboratory periods, credit, 4.
The Department.

75. **I.** Farm Structures. — For seniors; juniors may elect. A study of the strength and durability of concrete, wood, stone, and clay products, and of the mechanical principles underlying their use in farm construction. The design of various farm buildings, such as the general purpose barn, dairy stable, hog house, sheep barn, milk house, etc. In the drafting room, details of construction will be worked out, a study of the mechanics of simple roof trusses will be made, and a complete design of some major farm building will be finished in all essential details. If time permits, blueprints of the finished design can be made.

2 class hours. 3 2-hour laboratory periods, credit, 5.
The Department.

78. **II** and **III.** Farm Motors. — For seniors; juniors may elect. This course deals with the gasoline engine as used for stationary work, automobiles and tractors. Instruction is given by means of lectures and textbooks, and by

operating and repairing stationary engines, automobiles and tractors. Special attention is given to overhauling and repairing.
3 class hours. 2 2-hour laboratory periods, credit, 5.
The DEPARTMENT.

79. **III.** DRAINAGE AND IRRIGATION ENGINEERING. — For seniors; juniors may elect. Covers the engineering phase of drainage and irrigation. The various systems are studied, and practice is given in the design of drainage and irrigation systems. Field work gives practice in surveying for drains, platting, locating drains, erecting batterboards and laying tile. Practice is given in assembling equipment for spray irrigation, and the flow of water through nozzles is studied by means of laboratory tests.
2 class hours. 2 3-hour laboratory periods, credit, 5.
The DEPARTMENT.

81. **III.** DAIRY MECHANICS. — For juniors; seniors may elect. A study of dairy machinery, including steam boilers, engines, pumps, traps, refrigeration machinery, and heat-controlling devices. Practice is given in pipe fitting, packing valves, lacing belts, and similar repair jobs on the equipment used in dairy plants.
3 class hours. 1 3-hour laboratory period, credit, 4.
Professor GUNNESS and Mr. NEWLON.

DIVISION OF HORTICULTURE.

Professor WAUGH.

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Floriculture.

Professor THAYER, Assistant Professor MULLER.

The courses in floriculture are intended to present a general knowledge of all phases of greenhouse design, construction, heating and management, the culture of florists' crops (under glass and in the field), floral decoration and arrangement. The department aims to train students so that they may take up commercial floriculture (either in the growing or retail business) and the management of conservatories on private estates, in parks and cemeteries.

The department is especially well equipped for the teaching work, probably being surpassed in no other agricultural college. French Hall, with its laboratories, classrooms and offices, furnishes excellent facilities for the purposes of instruction. The glass area of the department consists of approximately 20,000 square feet, divided as follows: French Hall range of 7,200 square feet, a durable, practical, commercial range composed of palm and fern, violet, carnation, rose and students' houses; the old Durfee range of 7,400 square feet, devoted to the growing of decorative, conservatory and bedding plants and chrysanthemums; one house of 3,200 square feet, suitable for propagating work and general plant culture; and approximately 2,200 square feet in cold frames and hotbeds.

In addition, the department has 2 acres of land used for the summer culture of carnations, violets, gladioli, dahlias, sweet peas, bedding plants, etc. This also includes a small garden of about 4,700 square feet devoted to the culture of annuals. A large collection of biennials and herbaceous perennials is maintained and is being enlarged from year to year; at the present time the collection consists of several hundred species and varieties, and provides an excellent opportunity for the study of garden flowers.

Elective Courses.

50. **I.** GREENHOUSE MANAGEMENT. — For juniors; seniors may elect. Designed to familiarize students with the methods followed in the management of greenhouses and of greenhouse crops and the principles underlying the same; history and development of the floricultural industry; preparation of soils; fertilizers; potting; watering; ventilation; control of insects and diseases; methods

of plant propagation; forcing of plants. At some time during the term the members of the class will be required to take a one-day trip to visit large commercial establishments. Lectures, assigned readings, reports and laboratory practice.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Assistant Professor MULLER.

Prerequisite, Horticulture 25 and 26.

51. **II.** GREENHOUSE MANAGEMENT. — For juniors; seniors may elect. Continuation of Course 50. Several field trips, to study floricultural establishments in the vicinity, will be made during the laboratory periods.
2 class hours. 1 4-hour laboratory period, credit, 4.
Assistant Professor MULLER.

52. **III.** FLORAL ARRANGEMENT. — For juniors; seniors may elect. A study of the principles underlying the arrangement and use of cut flowers and plants; funeral designs, basket and vase arrangement, table decorations, home, church and all interior decorations; a study of color as applied to such work. Lectures, assigned readings and reports. This course will be limited to ten students.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Professor THAYER.

53. **I.** GREENHOUSE CONSTRUCTION AND HEATING. — For juniors; seniors may elect. The location, types, arrangement, construction, cost, equipment, heating and ventilating of greenhouse structures; the drawing of plans and study of specifications for commercial houses and conservatory ranges. Such practical work as glazing and the construction of concrete benches and cold frames is included as facilities allow. Lectures, assigned readings and problems.
3 class hours. 1 2-hour laboratory period, credit, 4.
Professor THAYER.

55. **III.** GARDEN FLOWERS AND BEDDING PLANTS. — For juniors and seniors. A study of the annuals, biennials, herbaceous perennials, bulbs, bedding plants and roses that are valuable for use in floricultural or landscape gardening work. Methods of propagation, culture and uses of the various plants are considered; identification of material. Lectures, assigned readings and reports.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professors THAYER and MULLER.

75. **I.** COMMERCIAL FLORICULTURE. — For seniors. A detailed study of the important commercial cut flower crops and potted plants. Visits will be made to commercial establishments during the term. The lectures are supplemented with textbooks and assigned readings.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor THAYER.

Prerequisite, Floriculture 51.

76. **II.** COMMERCIAL FLORICULTURE. — For seniors. As stated under Course 75.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor THAYER.

Prerequisite, Floriculture 75.

77. **III.** COMMERCIAL FLORICULTURE. — For seniors. As stated under Course 75.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor MULLER.

Prerequisite, Floriculture 76.

79. **II.** Conservatory Plants. — For seniors. A study of the foliage and flowering plants used in conservatory work; methods of propagation, culture, use and arrangement; identification of plants. Lectures, assigned readings and reports.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Thayer.

Prerequisite, Floriculture 51.

80. **III.** Seminar. — For seniors majoring in floriculture. Advanced study of subjects pertaining to some phase of floriculture. All students are assigned specific problems and pursue study in these problems by reading and research; the results of this study must be presented in the form of a thesis. Seminars are conducted weekly.
1 class hour. 2 to 4 laboratory hours, not to exceed 3 credits.
Professor Thayer.

Forestry.

Professor Grose.

The forestry courses are intended primarily for prospective owners or managers of farm woodlots, and the field work is focused on typical New England problems. These courses are broad enough, however, to furnish valuable preparation for students planning to study forestry in graduate schools.

The department has an unusually complete equipment of the various instruments used in forest mensuration, forest mapping and engineering, timber estimating, log scaling, board measuring, etc.; and a large assortment of boards illustrative of the various commercial woods found in the lumber markets. The State Forest Nursery, comprising 14 acres of land and containing, approximately, 10,000,000 trees, transplants and seedlings, is on the college farm. Forests containing every variety of tree common to New England are within walking distance of the college. The college campus affords an arboretum containing a large number of trees not native to New England. The Mount Toby Demonstration Forest has an area of approximately 750 acres, and contains the various types of forest growth found throughout the State. It serves as a field laboratory in which students have the privilege of working out problems in silviculture, forest mensuration and management. Improvement cuttings, cuttings for utilization, and forest plantings are conducted by the department.

55. **I.** Woodlot Forestry: Estimating and Business Management. — For juniors and seniors. Topics: forest mapping; timber-cruising; determining rate of growth and possible cut; financial returns; forest taxation; our national timber supply, present and future.
1 2-hour and 1 4-hour laboratory period, credit, 3.
Professor Grose.

56. **II.** Woodlot Forestry: Logging, Milling and Marketing. — For juniors and seniors. Topics: felling trees; sawing logs; hauling logs; the portable mill; the stationary mill; seasoning, measuring and shipping lumber; lumber grades and prices; legal forms; by-products of the woodlot; adaptability of species to uses; wood-using industries of Massachusetts.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Grose.

Prerequisite, Forestry 55.

57. **III.** Woodlot Forestry: Timber-raising. — For juniors and seniors. Topics: forest planting; weeding; release cuttings; pruning; thinning; salvage cutting; protection from insects, fungi, fire, etc.; final cutting methods for natural reproduction of the forest.
1 2-hour and 1 4-hour laboratory period, credit, 3.
Professor Grose.

58. **III.** Woodlot Forestry: Brief Survey. — For juniors and seniors. A condensation of Courses 55, 56 and 57 for those who have only one term to give to forestry.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Grose.

Horticultural Manufactures.

Professor Chenoweth, Mr. Robertson.

The courses aim to give a practical knowledge of the problems connected with food preservation. Emphasis is placed upon the conservation of the cheaper grades of fruits and vegetables, to the end that the whole crop may be marketed at a profit and that wholesome food products may result from what would otherwise be lost. The social and economic values of this work are constantly emphasized.

The department occupies three laboratory rooms in Flint Laboratory, two in Fisher Laboratory, with offices in Wilder Hall and French Hall. The general equipment of the department, both for the use of students and for manufacturing purposes, may be grouped under the following heads: —

1. *Canning.* — A modern canning outfit, including both steam-pressure cookers and hot-water baths, hand and power can sealers, peeling and slicing machines, a string bean cutter, heat-penetration thermometers, electric incubator and a large assortment of all types of home canning equipment.
2. *Evaporation.* — Two small orchard evaporators, a tunnel drier, peeling machines, slicers and a general assortment of driers adapted to home evaporation.
3. *Fruit Juices, Butters, etc.* — A hand cider mill, a motor-driven hydraulic press, a steam-jacketed kettle, an apple-butter cooker, and cider and vinegar testing apparatus.

Elective Courses.

75. **I.** Horticultural Manufactures. — For seniors and graduate students. A practical course in food preservation dealing primarily with fruits and vegetables. The canning of fruits and vegetables as practiced in the home and in commercial canneries; evaporation of fruits and vegetables, the various types of equipment and methods of preparation of products. The manufacture of (*a*) fruit products, such as butters, jams, jellies, fruit juices, marmalades, preserves, vinegars, pastes, etc.; (*b*) vegetable products, as pickles, piccalilli, sauerkraut, soups, etc. Particular attention is given to study and use of all types of equipment suitable for use in the home or small factory, together with methods for testing a large variety of manufactured products. The emphasis is on canning, drying and study of equipment.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor Chenoweth.

76. **II.** Horticultural Manufactures. — For seniors and graduate students. A continuation of Course 75. The emphasis in this course is placed on the manufacturing and testing of fruit and vegetable products.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Chenoweth.
Prerequisite, Horticultural Manufactures 75.

77. **III.** Horticultural Manufactures. — For seniors and graduate students. Continuation of courses 75 and 76, dealing primarily with maple products, the canning of meats and spring vegetables, and studies of special problems involved in establishing and operating home and farm factories.
2 2-hour laboratory periods, credit, 2.
Professor Chenoweth.

78. **III.** Horticultural Manufactures. — For seniors and graduate students. A general course in food preservation, including lectures, readings and laboratory work in the canning and evaporation of fruits and vegetables, the

manufacture of fruit and vegetable products. Special emphasis will be given to the conservation of the low-grade fruits and vegetables in the home and in the farm factory.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Professor Chenoweth.

80. **I.** Horticultural Manufactures. — For seniors. A course dealing with the problems of food preservation in the home. Application of present-day knowledge to the practices of canning, pickling, drying and the manufacture of fruit and vegetable products in the home.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Professor Chenoweth and Mr. Robertson.

Horticulture.

Professor Waugh, Professor Thompson, Assistant Professor Dickinson, Mr. Arrington.

The general subject of horticulture divides naturally into subjects of pomology, floriculture, forestry, landscape gardening and vegetable gardening. A number of courses relate to more than one of these subjects, and are therefore grouped here under the general designation of horticulture.

Required Courses.

25. **I.** Taxonomy and Ecology of Horticultural Plants. — For sophomores. A study of the outstanding botanical characters of the principal families, genera, species and varieties of cultivated plants; together with a consideration of those principles of ecology utilized in the cultivation of plants.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Thompson.

26. **II.** Physiology of Horticultural Plants. — For sophomores. This course is designed to demonstrate and explain the principles of plant physiology in their practical application to the cultivation of economic plants. Consideration will be given to the methods of propagation and to the culture of plants in their relation to soils, tillage, water and food supply, etc.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Drain.

27. **III.** Breeding of Horticultural Plants. — For sophomores. A study of the principles of inheritance as applied to plants; together with a consideration of the methods used and problems involved in the improvement of cultivated plants.
5 class hours. Credit, 5.
Mr. French.

Elective Courses (General).

50. **I.** Plant Materials. — For juniors; seniors may elect. Aims to make the student familiar with the character of the trees, shrubs and herbaceous perennials used in ornamental work, and with the methods of propagating them.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Thompson.

51. **III.** Plant Materials. — For juniors; seniors may elect. A continuation of Course 50, taking up the field use of trees, shrubs and herbaceous plants, their native habitats, soils and plant associations, with a view to supplying to students in landscape gardening and floriculture a knowledge of plant species. Frequent practicums and field excursions.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor Thompson.

Prerequisite, Horticulture 50.

Landscape Gardening.

Professor WAUGH, Assistant Professor HARRISON, Assistant Professor QUINLAN.

The purposes of the courses are: (1) To train men for the profession in all its branches. As a rule graduates should first enter the employ of established landscape architects, nurserymen or park superintendents, and after an apprenticeship of several years those who have the requisite technical and business ability may set up for themselves. (2) To train men for public-service work in national, State and municipal parks and forests. (3) To train men for country planning, this function being exercised through various public institutions and organizations. (4) To train teachers and extension workers in lines of landscape gardening and civic improvement. (5) To give a broad and liberal general education stressing the fundamental principles of art.

The department has large, well-lighted drafting rooms, with necessary equipment, such as planimeters, eidograph, pantograph, blueprinting outfit, etc.; and a complete outfit of surveying instruments, including transits, levels, plane tables, prismatic compasses, hand levels, etc. The college campus presents an unusually good collection of the plant materials used in landscape gardening.

Required Course.

30. **I.** ELEMENTARY DESIGN. — For sophomores. Offered for the year 1925–26.

3 2-hour laboratory periods, credit, 3.

Elective Courses.

50. **I.** MAPPING AND TOPOGRAPHY. — For juniors. Reconnoissance surveys and mapping, with special reference to the methods used in landscape gardening; detailed study of selected designs of leading landscape gardeners; grade design, road design and field work. Must be followed by Course 51.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, 5.
Assistant Professor HARRISON.

Prerequisites, Mathematics 26 and 27, Drawing 25, 26 and 27.

51. **II.** ELEMENTS OF LANDSCAPE GARDENING. — For juniors. As stated under Course 50.

3 3-hour laboratory periods, credit, 4.
Assistant Professor HARRISON.

Prerequisite, Landscape Gardening 50.

52. **III.** GENERAL DESIGN. — For juniors. Field notes; examination of completed works and those under construction; design of architectural details, planting plans, gardens, parks and private grounds; written reports on individual problems.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, 5.
Assistant Professor HARRISON.

Prerequisites, Landscape Gardening 50 and 51, and either plant materials (Horticulture 50 and 51) or advanced mathematics.

75. **I.** THEORY OF LANDSCAPE ART. — For seniors and graduates. The general theory and applications of landscape study, including a brief history of the art.
3 class hours. Credit, 3.
Professor WAUGH.

76. **I.** CIVIC ART. — For seniors. The principles and applications of modern civic art, including city planning, city improvement, village improvement and rural improvement, with special emphasis upon country planning. Must be followed by Course 77.

3 3-hour laboratory periods, credit, 4.
Assistant Professor QUINLAN.

Prerequisite, Landscape Gardening 52.

77. **III.** Country Planning. — For seniors. As stated under Course 76.
3 3-hour laboratory periods, credit, 4.
Professor Waugh.

Prerequisite, Landscape Gardening 76.

78. **I.** Architecture (1926–27). — Alternates with Course 79. For juniors and seniors. The history of architectural development, the different historic types, with special reference to the underlying principles of construction and design and their relations to landscape design. Illustrated lectures, conferences, practice in designing.
3 class hours. Credit, 3.
Assistant Professor Harrison.

79. **I.** Construction and Maintenance (1925–26). — Alternates with Course 78. For juniors and seniors. Detailed instruction in methods of construction and planting in carrying out plans, in organization, reporting, accounting, estimating, etc.; maintenance work in parks and on estates, its organization, management, cost, etc.
3 class hours. Credit, 3.
Assistant Professor Harrison.

80. **II.** Theory of Design. — For seniors. As stated under Course 52.
3 3-hour laboratory periods, credit, 4.
Professor Waugh.

Prerequisite, Landscape Gardening 52.

81. **II.** Estate Design. — For seniors.
3 3-hour laboratory periods, credit, 4.
Assistant Professor Harrison.

82. **III.** Park Design. — For seniors.
3 3-hour laboratory periods, credit, 4.
Assistant Professor Harrison.

Pomology.

Professor Sears, Professor Van Meter, Assistant Professor Drain, Mr. French, Mr. Raleigh.

The object of the course is to give a training which shall be thoroughly practical and yet scientific. This will fit the men to enter the field of practical fruit growing, or it will furnish an excellent foundation for further study.

The department has 50 acres in fruit plantations. The apple orchards comprise about 35 acres, and there are blocks of pears, peaches, plums and cherries. In small fruits there are plantings of strawberries, raspberries, blackberries, currants and gooseberries. There are three vineyards, with a total area of 5 acres, in which the leading varieties and the principal types of pruning and training are represented. In these plantations are 50 varieties of grapes, representing three native American species and many hybrids; 20 varieties of peaches; 20 varieties of pears; 25 of plums, including five species and many hybrids; and 100 varieties of apples.

The department has an excellent equipment of spraying and dusting machinery, including various styles and sizes of power sprayers, and many types of barrel pumps and smaller sprayers. There is also an excellent assortment of orchard tools, including plows, harrows, fertilizer sowers, etc.

Fisher Laboratory is one of the best planned and equipped packing and storage plants in the United States. It includes six refrigerated rooms; four storage rooms not refrigerated; one large laboratory room and one classroom, besides ample storage room for fruit packages and equipment. The equipment for the building itself includes four types of apple sizers; packing tables and box and barrel presses of various types, besides all kinds of packages and the smaller equipment necessary for thoroughly modern work in grading and packing fruit. The department is equipped with lockers and with pruning and other tools for the use of students in laboratory work, which is made a leading feature in all the courses in pomology.

Elective Courses.

50. **I.** Practical Pomology. — For juniors; seniors may elect. A study of the general principles of the growing of fruits, dealing with such questions as selection of site, soils, windbreaks, laying out plantations, choice of nursery stock, pruning, culture of orchards, orchard fertilizers, cropping orchards, etc. Lectures, supplemented with text and reference books; field and laboratory exercises.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Sears and Mr. French.

Prerequisite, Horticulture 26.

51. **II.** Practical Pomology. — For juniors; seniors may elect. As stated under Course 50.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Sears and Mr. French.

Prerequisite, Pomology 50.

52. **III.** Small Fruits. — For juniors; seniors may elect. A study of the growing of small fruits, including raspberries, blackberries, strawberries, currants, gooseberries and grapes, dealing with such questions as their propagation, selecting a site for the plantation, soils, fertilizers, pruning, etc.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Sears and Mr. French.

Prerequisite, Pomology 51.

54. **II.** Systematic Pomology. — For juniors; seniors may elect. A study of varieties of fruits including identification, nomenclature, relationships and classification. This course is advised but not required of candidates for the varsity fruit judging team. Lectures, laboratory and field exercises.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Drain.

75. **I.** Systematic Pomology. — For seniors. A continuation of Course 54, with special reference to nursery variety certification, variety study of pears, grapes, plums, cherries, strawberries, raspberries, blueberries and blackberries.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Drain.

Prerequisite, Pomology 54.

76. **II.** Orchard Management. — For seniors. This course will consider the more important problems in connection with the organization and management of a fruit farm. Specialization and diversification and the place of each of the common fruit crops on the farms of Massachusetts will be studied in relation to the distribution of labor and income. The combination of fruit growing with other lines of farming will be discussed in connection with conditions in this State and combinations in successful operation will be studied. The course is intended to bring principles learned in the previous years in college to bear upon the particular problems of the fruit grower.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Van Meter.

Prerequisite, Pomology 51.

77. **I.** Commercial Pomology. — For seniors. The picking, handling, storing and marketing of fruits, including a discussion of storage houses, fruit packages, methods of grading and packing. Especial emphasis is placed upon laboratory and field work, where the student is given actual practice in the picking and packing of all the principal fruits.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Mr. Raleigh.

Prerequisite, Pomology 51.

78. **III.** Spraying. — For seniors. A study of (*a*) spraying materials, their composition, manufacture and preparation for use; the desirable and objectionable qualities of each material, formulas used, cost, tests of purity. (*b*) Spraying machinery, including all the principal types of pumps, nozzles, hose and vehicles; their structure and care. (*c*) Orchard methods in the application of the various materials used, with the important considerations for spraying each fruit and for combating each orchard pest. This course is designed especially to familiarize the student with the practical details of actual spraying work in the orchard. Spray materials are prepared, spraying apparatus is examined and tested, old pumps are overhauled and repaired, and the actual spraying is done in the college orchards and small-fruit plantations.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Drain.

Prerequisite, Pomology 76.

79. **II.** General Pomology. — For seniors; juniors may elect. Planned to meet the needs of students who cannot devote more than one term to the subject but who want a general knowledge of fruit growing. Consists of lectures and laboratory exercises on such topics as choosing the locations, kinds and varieties of fruits to grow, securing and setting the plants, care and cultivation, pruning, spraying, pests, harvesting and storing.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Drain.

80. **I.** Seminar. — For seniors majoring in pomology. Advanced study of problems relating to the business of fruit growing. Each student is assigned a major and a minor problem in lines of work in which he is particularly interested. He pursues his studies both by reading and research, and the materials obtained will be worked into theses which are presented to the seminar for discussion. No lectures are given, but seminar meetings are held for one period each week.
1 class hour. Credit, 1.
The Department.

81. **II.** Seminar. — For seniors majoring in pomology. A continuation of Course 80. One seminar meeting each week.
1 class hour. Credit, 1.
The Department.

82. **III.** Seminar. — For seniors majoring in pomology. A continuation of Course 81. One seminar meeting each week.
1 class hour. Credit, 1.
The Department.

Vegetable Gardening.

Professor Waugh, ———, Mr. Snyder.

The courses in Vegetable Gardening are designed for students who wish to enter commercial vegetable growing, the seed business, or professional work, such as teaching or experimental work. Each of these fields offers wide possibilities and the advancement of vegetable production will depend upon the number and quality of the men trained along these lines.

The department has ten acres of land, 3,800 sq. ft. of greenhouse space, and 150 hotbed sash, all of which are used to provide laboratory facilities. Part of this equipment is used for the non-commercial laboratory work, such as the students' gardens and the type and variety garden, while the remainder is devoted to commercial laboratory work.

In addition the department maintains at Waltham, Massachusetts, the Market Garden Field Station. Here the experimental and extension work of the department is carried on.

Elective Courses.

50. **III.** General Vegetable Gardening. — For juniors; seniors may elect. A general course for those students who desire a general knowledge of agriculture, but do not care to spend the time for extreme specialization. Designed to teach the fundamentals of vegetable growing so they may be applied (1) to the growing of vegetables commercially as a cash crop with other types of agriculture, (2) to the growing of vegetables in the home garden, (3) to agricultural teaching in secondary schools, and (4) to professional agricultural work other than teaching.
3 class hours. 2 2-hour laboratory periods, credit, 5.

52. **II.** Practical Vegetable Gardening. — For juniors; seniors may elect. Courses 52 and 53 are designed for those students who wish to obtain a knowledge of vegetable growing in order that they may apply this to the successful commercial production of vegetables, or to become fitted for professional work such as teaching and research work. The course begins with a consideration of vegetables as a food, the part they play in the food supply of the city, State, or nation, and Massachusetts' part in this type of food production, followed by a study of the fundamentals of vegetable gardening. Deals with such questions as the selection of a location; soils, manures and fertilizers, green manures and cover crops; seeds and seeding; planting, tillage, irrigation; control of insects and diseases. Includes a detailed study of the cultural requirements of the common vegetable crops, and the principles of rotation and double cropping. Text and reference books. Laboratory and field exercises.
3 class hours. 2 2-hour laboratory periods, credit, 5.

Prerequisites, Horticulture 26, Agronomy 75.

53. **III.** Practical Vegetable Gardening. — For juniors; seniors may elect. As stated under Course 52.
3 class hours. 2 2-hour laboratory periods, credit, 5.

Prerequisite, Vegetable Gardening 52.

75. **I.** Types and Varieties. — For seniors. Includes the systematic study of types, varieties and strains of the leading vegetable crops; exhibiting and judging of vegetables; determination of quality in vegetables; seed growing, variety improvement, rogueing, seed harvesting, curing and storing.
3 class hours. 2 2-hour laboratory periods, credit, 5.

Prerequisite, Vegetable Gardening 53 or 50.

76. **II.** Vegetable Forcing. — For seniors. A study of types, materials, construction, location, arrangement, capacity and cost of greenhouses for growing vegetables. A brief consideration of the heating plant, — the type, installation, piping and management; also the study of greenhouse vegetable crops and their production as practiced by commercial growers.
3 class hours. 2 2-hour laboratory periods, credit, 5.

Prerequisite, Vegetable Gardening 53 or 50.

77. **III.** Commercial Vegetable Growing. — For seniors. A consideration of vegetable growing as a business. A study of this specialized type of farming, including places where developed, types, extent, economic importance, capitalization, equipment and other fundamental problems of commercial vegetable gardening. Students assist in the planning and operation of a typical market-gardening area. Visits are made to market-gardening and truck-gardening farms.
3 class hours. 2 2-hour laboratory periods, credit, 5.

Prerequisite, Vegetable Gardening 53 or 50.

Drawing.

Required Courses.

25. **I.** Free-hand Drawing. — For sophomores; juniors and seniors may elect. Lettering; free-hand perspective; sketching from type models, leaves, flowers and trees, houses, etc.; laying flat and graded washes in water colors; water-color rendering of leaves, flowers and trees; conventional coloring and map rendering in water-colors; conventional signs and mapping in ink.
4 2-hour laboratory periods, credit, 4.

26. **II.** Mechanical Drawing. — For sophomores; juniors and seniors may elect. Inking exercises; geometric problems; projection; intersections; isometric; shades and shadows; parallel; angular and oblique perspective; perspective drawing of buildings. Students should have preparation in plane and solid geometry.
3 2-hour laboratory periods, credit, 3.

27. **III.** Mechanical Drawing. — For sophomores; juniors and seniors may elect. As stated under Course 26.
4 2-hour laboratory periods, credit, 4.

Prerequisite, Drawing 26.

DIVISION OF SCIENCE.

Professor Fernald.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Botany.

Professor Osmun, Assistant Professor Clark, Assistant Professor McLaughlin, Assistant Professor Torrey, Assistant Professor Davis.

A knowledge of the principles of plant life is fundamental in agricultural education. The required courses in botany are planned with this and the general educational value of the subject in view. Elective courses are of two types: (1) those which have for their chief aim the direct support of technical courses in agriculture and horticulture, and (2) those providing broader, more intensive training in the science. Courses in the second group may lead, when followed by postgraduate study, to specialization in the field. They also furnish excellent training for those specializing in other sciences and in scientific agriculture. In all undergraduate courses the relation of the science of botany to agriculture is emphasized.

The department occupies Clark Hall, a brick building 55 by 95 feet, two stories high, with basement and attic. The building has two lecture rooms with seating capacity of 154 and 72, respectively; one seminar and herbarium room; large laboratories for general and special work; and smaller rooms for advanced students. A glass-enclosed laboratory for plant physiology adjoins the main building and provides unusual facilities for the study of phenomena of plant life. In addition, a greenhouse 28 by 70 feet is connected with the building. This is for experimental work in plant pathology and physiology, and for growing plants needed for instruction. The experiment station laboratories devoted to botanical research are in this building.

The laboratories and lecture rooms are of modern construction, finely lighted and equipped with compound and dissecting microscopes, microtomes, paraffine and drying ovens, physiological and other apparatus, and a large collection of charts. The herbarium contains about 20,000 sheets of seed plants and ferns, 1,200 sheets of liverworts and mosses, and 25,000 specimens of fungi. Facilities and equipment for the study of plant physiology and pathology are excelled in few other institutions.

Required Courses.

3. **III.** Introductory Botany. — For freshmen. Presents the seed plants as plastic organisms molded by their environment. Also introduces the student to methods of identifying and classifying plants.
2 class hours. 2 2-hour laboratory periods, credit, 4.
Assistant Professor Torrey.

25. **I.** Introductory Botany. — For sophomores. The anatomy and physiology of the seed plants (Phanerogamia).
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Torrey.

Prerequisite, Botany 3.

26. **III.** Morphology and Taxonomy of the Lower Plants (Cryptogamia). — For sophomores. Systematic study of typical forms of bacteria, algæ, fungi, lichens, mosses, ferns. (Courses 3, 25 and 26 constitute a general elementary course in botany, and are required of all students who major in science.)
1 class hour. 3 2-hour laboratory periods, credit, 4.
Professors Osmun and McLaughlin.

Prerequisite, Botany 25.

Elective Courses.

50. **I.** Diseases of Crops. — For juniors; seniors may elect. The lectures are general and are taken by all who elect the course, but in order to permit students to specialize on the diseases of crops most closely related to their majors or in which they are most interested, the course is divided for lecture and laboratory work into the following sections: (I) diseases of truck and field crops; (II) diseases of floricultural crops and ornamentals; (III) diseases of fruit crops; (IV) diseases of shade and forest trees. One, two or three laboratory sections may be taken.
1, 2 or 3 class hours. 1, 2 or 3 2-hour laboratory periods, credits, 2, 4 or 6.
Assistant Professor McLaughlin.

Prerequisites, Botany 3 and 25.

51. **II.** Diseases of Crops. — For juniors; seniors may elect. As stated under Course 50.
1, 2 or 3 class hours. 1, 2 or 3 2-hour laboratory periods, credits, 2, 4 or 6.
Assistant Professor McLaughlin.

Prerequisite, Botany 50.

52. **I.** Systematic Mycology. — For juniors; seniors may elect. Morphology and development of typical species representing the orders and families of fungi; practice in identification, collection and preservation of fungi; study of system of classification; collateral reading. A prerequisite of the senior course in plant pathology, but open to all.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Davis.

Prerequisite, Botany 26.

53. **II.** Systematic Mycology. — For juniors; seniors may elect. As stated under Course 52.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Davis.

Prerequisite, Botany 52.

54. **III.** Systematic Mycology. — For juniors; seniors may elect. As stated under Course 52.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Davis.

Prerequisite, Botany 53.

55. **III.** Plant Histology. — For juniors; seniors may elect. Comparative study of the tissue of plants; training in histological methods, including the use of precision microtomes, methods of killing, fixing, sectioning, staining and mounting; collateral reading and conferences. This course offers valuable training in preparation for further work in botany.

5 2-hour laboratory periods, credit, 5.
Assistant Professors McLaughlin, Torrey and Davis.

Prerequisite, Botany 3 and 25.

58. **I.** Systematic Botany of the Higher Plants (1926–27). — For juniors and seniors. An intensive study of gymnosperms and angiosperms. Lectures deal with the interrelations of the flowering plants and with their ecology, distribution and economic importance. Laboratory work consists of a critical study of types from the most important natural plant families. Particular emphasis is laid on the flora of Massachusetts. The department herbarium and greenhouses supply material of important tropical forms for study. Alternates with Course 61.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Torrey.

59. **II.** Systematic Botany of the Higher Plants (1926–27). — For juniors and seniors. As stated under Course 58. Alternates with Course 62.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Torrey.

60. **III.** Systematic Botany of the Higher Plants (1926–27). — For juniors and seniors. As stated under Course 58. Alternates with Course 63.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Torrey.

61. **I.** The Comparative Anatomy of Green Plants (1925–26). — For juniors and seniors. In the lectures an intensive study is directed to the comparative anatomy of green plants from the evolutionary standpoint. Particular emphasis is laid upon the woody forms both living and extinct. Of the latter, the department is fortunate in possessing excellent sets of micro-preparations and lantern slides. Alternates with Course 58.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Torrey.

62. **II.** The Comparative Anatomy of Green Plants (1925–26). — For juniors and seniors. As stated under Course 61. Alternates with Course 59.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Torrey.

63. **III.** The Comparative Anatomy of Green Plants (1925–26). — For juniors and seniors. As stated under Course 61. Alternates with Course 60.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Torrey.

75. **I.** Plant Pathology. — For seniors. Comprehensive study of diseases of plants; training in laboratory methods and technique, including culture work and artificial inoculation of hosts; miscellaneous diagnosis; study of literature and representative life histories of pathogens. Prepares for civil service, experiment station and college work.
1 class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Davis.

Prerequisite, Botany 54.

76. **II.** Plant Pathology. — For seniors. As stated under Course 75.
1 class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Davis.

Prerequisite, Botany 75.

77. **III.** Plant Pathology. — For seniors. As stated under Course 75.
1 class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Davis.

Prerequisite, Botany 76.

78. **I.** Plant Physiology. — For seniors. Study of the factors and conditions of (*a*) Plant Nutrition, including the taking up of water and mineral substances, the assimilation of carbon and nitrogen, and the release of energy due to the processes of dissimilation; (*b*) Plant Growth, including the influence of internal and external factors on growth, the development of reproductive and vegetative organs; (*c*) Plant Movements, including those due to the taking up of water, and those movements of both motile and fixed forms in response to external stimuli. Weekly conferences are held at which students report on assignments to original sources in the literature.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor Clark.

Prerequisites, Botany 26 and Chemistry 51.

79. **II.** Plant Physiology. — For seniors. As stated under Course 78.
2 class hours. 1 or 3 2-hour laboratory periods, credit, 3 or 5.
Assistant Professor Clark.
Prerequisite, Botany 78 for the 10-credit course, Botany 25 for the 6-credit course.

80. **III.** Plant Physiology. — For seniors. As stated under Course 78.
2 class hours. 1 or 3 2-hour laboratory periods, credit, 3 or 5.
Assistant Professor Clark.

Prerequisite, Botany 79.

General and Agricultural Chemistry.

Professor Lindsey, Professor Chamberlain, Professor Peters, Assistant Professor Serex, Dr. Butler.

In teaching the courses in chemistry, emphasis is laid on both their educational and their vocational value. The courses in the freshman year deal with fundamental principles, and give the student such an understanding of the subject as will enable him to apply it in farm practice. The more advanced courses, including quantitative analysis, organic, physiological and physical chemistry, are for those who intend to become teachers and workers in the allied sciences, or who desire to follow agricultural chemistry as a vocation. Advanced training is given by means of postgraduate courses (see Graduate School).

Those completing the undergraduate courses are fitted for positions in the agricultural industries, — fertilizer, feed and insecticide manufacture, — as well as in other lines of industry, and in the State experiment stations, in commercial laboratories, and in high school teaching. Postgraduate students are prepared for positions as teachers in colleges, and for more advanced positions in industry and in the experiment stations.

The new Goessmann Chemistry Laboratory was opened for classes in September, 1924.

Required Courses.

The freshman work consists of two distinct parts: Courses 1 and 2 contain more hours and are for those who have had no chemistry in the secondary schools, and Courses 4 and 5 are for those who have presented chemistry for entrance. Both groups of courses bring the student out at the same point. It is obviously to the advantage of the student to take a course in chemistry in high school and thus obviate the extra hours of Courses 1 and 2 in the freshman year.

1. **I.** General Chemistry. — For freshmen. This course is for those students who do not present chemistry for entrance and who begin the subject in college. An introduction to the fundamental chemical laws, together with a study of the typical acid- and base-forming elements and their compounds.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Dr. Butler.

2. **II.** Agricultural Chemistry. — For freshmen. A continuation of Course I. A study of the common elements. Special emphasis on the application of the fundamental chemical laws particularly in connection with agriculture and every-day life. The preparation of a number of substances important in agriculture, such as superphosphate, ammonium sulfate, muriate and sulfate of potash, Paris green, arsenate of lead, Bordeaux mixture, lime-sulfur and emulsions. These materials are prepared in the laboratory and studied in detail in the classroom; some of the substances prepared may be analyzed. Particular attention will be given to a study of the composition, properties and reactions of soils. Approximate quantitative determinations of a number of constituents of soils and fertilizers will be made.

3 class hours. 2 2-hour laboratory periods, credit, 5.

Dr. Butler.

4. **I.** Advanced General Chemistry. — For freshmen. A review of general chemistry centered, for the most part, about the laboratory work. Textbooks, Holmes' "General Chemistry," and Peters' "The Preparation of Substances Important in Agriculture." The laboratory work takes the synthetic form. Substances of agricultural importance are prepared in quantity and studied in detail by the student. These include ammonium sulfate, superphosphate, muriate and sulfate of potash, arsenate of lead, Paris green, Bordeaux mixture, lime-sulfur and emulsions.

2 class hours. 2 2-hour laboratory periods, credit, 4.

Professor Peters.

Prerequisite, Entrance Chemistry.

5. **II.** Inorganic Agricultural Chemistry. — For freshmen. A study of the chemical composition, properties and reactions of soils, fertilizers, fungicides and insecticides. The laboratory work is divided into three parts: (*a*) qualitative examination of soil, plant ash and superphosphate; (*b*) approximate quantitative determination of moisture, ash, carbonic acid, phosphoric acid, potash, nitrogen, etc., in farm crops, soils and fertilizers; (*c*) special work on retention of salts by soil, leaching of lime from the soil by carbonated water, etc.

2 class hours. 2 2-hour laboratory periods, credit, 4.

Assistant Professor Serex.

25. **I.** Qualitative Analysis. — *Basic.* — For sophomores. The systematic analysis of metallic salts, presented from the ionic viewpoint. A close study of the tests used in the separation and identification of the metals, and the application of these tests to unknown mixtures. Text, Medicus' "Qualitative Analysis," with Stieglitz's "Qualitative Analysis" and Gooch and Browning's "Qualitative Analysis" for reference. This course should be taken by all intending to follow chemistry as a vocation.

1 class hour. 2 2-hour laboratory periods, credit, 3.

Assistant Professor Serex.

Prerequisite, Chemistry 2 or 5.

26. **II.** Qualitative Analysis. — *Acidic.* — For sophomores. A continuation of Course 25.

1 class hour. 2 2-hour laboratory periods, credit, 3.

Assistant Professor Serex.

30. **II.** Organic Agricultural Chemistry. — For sophomores; juniors and seniors may elect. Embraces the study of the most important groups of organic compounds of plants and animals, the composition of plants, the chemistry of plant growth, plants as food and as industrial material, the composition of animals, the chemistry of digestion, also the study of some of the products related to plants and animals, such as milk, butter, cheese, sugar and alcohol. The treatment of the subject is general, avoiding (so far as possible) complicated chemical facts and relationships, and endeavoring simply to make the student acquainted with the

general chemistry of plants and animals and agricultural processes and products. Textbook: Chamberlain's "Organic Agricultural Chemistry."
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor CHAMBERLAIN.

Elective Courses.

51. **I.** ORGANIC CHEMISTRY. — For juniors; seniors may elect. Consists of a systematic study, both from texts and in the laboratory, of the more important compounds in the entire field of organic chemistry. Especial attention is given to those compounds which are found in agricultural products or are manufactured from them. These include alcohols, acids, esters, fats, carbohydrates and proteins. The work forms a foundation for courses in physiological chemistry and agricultural analysis, and is especially planned for those majoring in chemistry or the other sciences. Textbook: Chamberlain's "Organic Chemistry." Those electing Course 51 are expected to elect Course 52.
3 class hours. 2 3-hour laboratory periods, credit, 6.
Professor CHAMBERLAIN.
Prerequisites, Chemistry 2 or 5, and Chemistry 26 for those majoring in chemistry.

52. **II.** ORGANIC CHEMISTRY. — For juniors; seniors may elect. A continuation of Course 51.
3 class hours. 2 3-hour laboratory periods, credit, 6.
Professor CHAMBERLAIN.

53. **III.** ORGANIC CHEMISTRY. — For juniors; seniors may elect. A continuation of Courses 51 and 52, dealing principally with compounds of the benzene series.
3 class hours. 2 3-hour laboratory periods, credit, 6.
Professor CHAMBERLAIN.

61. **I.** QUANTITATIVE ANALYSIS. — For juniors; seniors may elect. The course includes the gravimetric determination of chlorides, sulfates, iron, the volumetric analysis of acids and bases, and the dichromate method for iron. Text: Smith's "Quantitative Chemical Analysis."
1 class hour. 2 4-hour laboratory periods, credit, 5.
Professor PETERS.
Prerequisite, Chemistry 25. Course 26 is prerequisite for those majoring in chemistry.

62. **II.** For juniors; seniors may elect. A continuation of Course 61. A study of potassium permanganate as a volumetric reagent; limestone is analyzed; phosphorus is determined in soil; and the perchlorate method for potash is carried out. Analytical problems are a part of the work.
2 class hours. 2 4-hour laboratory periods, credit, 6.
Professor PETERS.

63. **III.** For juniors; seniors may elect. A continuation of Course 62. The study of the oxidation reactions of iodin, and precipitating reactions of thiocyanate; Paris green and lead arsenate are analyzed. The work closes with water analysis. By means of assigned readings students are shown the importance of library work. "Methods of the American Public Health Association" is used as a supplementary text.
1 class hour. 2 4-hour laboratory periods, credit, 5.
Professor PETERS.

75. **I.** PHYSICAL CHEMISTRY. — For seniors. A study of the fundamental theories and laws of physical chemistry together with laboratory work which includes the important methods of physicochemical measurements.
3 class hours. 6 laboratory hours, credit, 6.
Assistant Professor SEREX.

Prerequisite, Chemistry 61.

80. **I.** Physiological Chemistry. — For seniors. Supplementary to Courses 51, 52 and 53. To those who expect to take up scientific work in microbiology, botany, agronomy, animal husbandry, etc., and who have had Courses 51, 52 and 53, it gives acquaintance with the chemistry of the physiological processes in plants and animals, by means of which some of the important organic compounds studied in Courses 51, 52 and 53 are built up in the living organism or are used as food by it. In the lectures the study of food and nutrition as related to both human and domestic animals is the principal subject. In the laboratory experimental studies are made of the animal body and the processes and products of digestion, secretion and excretion.

3 class hours. 2 2-hour laboratory periods, credit, 5.

Dr. Butler.

81. **II.** Food Analysis. — For seniors. Primarily for the study of milk and butter analytically. May also include the analyses of other food stuffs for nutritive value or for impurities.

1 class hour. 2 4-hour laboratory periods, credit, 5.

Dr. Butler.

Prerequisite, Chemistry 61.

86. **II.** Review of General Chemistry. — For seniors. Primarily for students majoring in chemistry; others may elect by permission from the instructor. A knowledge of physical chemistry is desirable. The review of general chemistry is largely theoretical, using as text Alexander Smith's "Introduction to Inorganic Chemistry," or Mellor's "Modern Inorganic Chemistry." Some subjects may be enlarged by special lectures, such as: atomic structure, Werner's co-ordination theory, crystal structure as shown by X-rays.

3 class hours. Credit, 3.

Professor Peters.

87. **III.** History of Chemistry. — For seniors. An historical and biographical study of chemistry and chemists. The aim of the course is: (1) to give the student a comprehensive view of the science as a whole, through a study of the development of new ideas and the establishment of new theories and laws; and (2) to arouse an enthusiastic interest in the subject and an appreciation of the true spirit of scientific research through a sympathetic presentation of the work and lives of the great chemists who have been the creators of the chemistry of to-day. The course will consist of lectures, supplemented by systematic correlated reading, and the preparation of reports or essays.

3 class hours. Credit, 3.

Professor Chamberlain.

90. **II.** Special Work in Chemical Problems. — For seniors. An assignment is made to each student and he is expected to learn how research is done. The problem may be in analytical, general, agricultural or industrial chemistry, and is to be continued for two terms.

1 class hour. 8 laboratory hours, credit, 5.

Professor Peters.

91. **III.** Special Work in Chemical Problems. — For seniors. As stated under Course 90.

1 class hour. 8 laboratory hours, credit, 5.

Professor Peters.

92. **II.** Special Work in Organic Chemistry. — For seniors. In this course, as in Courses 90 to 97, the student may give his attention primarily to one line of chemical study for the purpose of becoming acquainted with methods of research. To those whose tastes and interests are in connection with the organic problems of agricultural chemistry, many subjects of study present themselves, among which may be mentioned: proteins, carbohydrates, fats, organic nitrogenous

compounds in fertilizers and soils and their relation to plants, the commercial production of alcohol from agricultural products, dyes, synthetic medicines, perfumes, etc.
1 class hour. 8 laboratory hours, credit, 5.
Professor CHAMBERLAIN.

Prerequisites, Chemistry 51, 52, 53 and 80.

93. **III.** SPECIAL WORK IN ORGANIC CHEMISTRY. — For seniors. As stated under Course 92.
1 class hour. 8 laboratory hours, credit, 5.
Professor CHAMBERLAIN.

Prerequisite, Chemistry 92.

94. **II.** SPECIAL WORK IN PHYSICAL CHEMISTRY. — For seniors. The field of agricultural chemistry offers many problems that have been attacked through the methods of physical chemistry; such, for example, are the hydrolysis of salts and of minerals and the absorption of salts and fertilizers by soils. For students interested in colloid chemistry a short course in the fundamentals may be pursued in this term with the ultimate object of selecting a problem along this line. This course is designed to familiarize the student with the literature on a special topic, and to give an insight into the methods of research. Each student selects one line of work and follows it through the course, repeating some of the original work.
1 class hour. 8 laboratory hours, credit, 5.
Assistant Professor SEREX.

Prerequisite, Chemistry 75.

95. **III.** SPECIAL WORK IN PHYSICAL CHEMISTRY. — For seniors. As stated under Course 94.
1 class hour. 8 laboratory hours, credit, 5.
Assistant Professor SEREX.

Prerequisite, Chemistry 94.

96. **II.** SPECIAL WORK IN PHYSIOLOGICAL AND FOOD CHEMISTRY. — For seniors. An opportunity for those so interested to pursue the study of some physiological or food problem. This course is intended to familiarize the student with the nature of research under the careful supervision of the instructor. The problems of physiological chemistry are of a varied and interesting character.
1 class hour. 8 laboratory hours, credit, 5.
Dr. BUTLER.

Prerequisite, Chemistry 80.

97. **III.** SPECIAL WORK IN PHYSIOLOGICAL AND FOOD CHEMISTRY. — For seniors. As stated under Course 96.
1 class hour. 8 laboratory hours, credit, 5.
Dr. BUTLER.

Prerequisite, Chemistry 80.

Entomology.

Professor FERNALD, Professor CRAMPTON, Assistant Professor ALEXANDER, Assistant Professor CASSIDY.

Introductory Course 26 or 28 presents a comprehensive view of the relation of insects to man, particularly as crop pests. The most important pests are carefully studied, together with the methods for their control. Courses 50 and 51 are arranged for special study of the pests of any one line of agricultural or horticultural occupation, selected by the student according to his plan of future work, with the intent of making him thoroughly familiar with the pests he will meet in his selected work after graduation, and the means of controlling them. The remaining courses are for the training of men as State or experiment station entomologists; for those going into the care of trees, etc., on estates, or for cities and towns; and as entomological experts, for which the demand has been very large.

Fernald Hall provides excellent lecture rooms and laboratories for this department. The laboratories are provided with individual desks, equipped with microscopes and all needed apparatus of all kinds. Dissecting microscopes, binoculars, microtomes, photographic apparatus, glassware and reagents are available for use and electric light and gas are connected with each desk. Two laboratories, one for juniors and seniors, the other for graduate students, are thus equipped. A department library containing all the more important works on insects, supplemented by others on the subject in the main library, and by the private libraries of the professors, make available more than 25,000 books and pamphlets on this subject. In addition, all the current magazines are received and their files are accessible to every one. A card catalogue giving references to the published articles on different insects contains about 65,000 cards, and is probably the largest index of its kind in the world. Spray pumps, nozzles and spraying appliances of all kinds are in use in various parts of the courses, and a large collection of insecticides is accessible for study. Photographic rooms are specially prepared for the photography of insects, and the greenhouses, gardens, orchards and the grounds of the college provide wide opportunities for the study, under natural conditions, of insect pests.

Course 26 or 28 is required of sophomores in the Divisions of Horticulture, Landscape Gardening, Science and Rural Social Science.

26. **III.** General and Economic Entomology. — For sophomores; juniors and seniors may elect. For students who desire some knowledge of insects, but who cannot give more than one term to the subject; also an introduction to the later courses for those who intend to follow entomology further. Touches briefly upon the structure of insects so far as this is needed for such a course; deals with metamorphosis, classification to the larger groups, and discusses the most important methods and materials used for control. The greater part of the time is devoted to special study of the most important insect pests, particularly of New England, showing their modes of life, the injuries they cause, and the best methods of control. In this way the most serious pests of fruit trees, ornamental trees and shrubs, market-garden and green-house pests, those attacking field crops and those affecting animals and man, are treated.

5 class hours. Credit, 5.

Professor Fernald.

28. **III.** General and Economic Entomology. — The same as 26 to about May 1; thereafter two class exercises and three laboratory or field exercises per week. In the field the work of insects found will be studied and collections of insects made. Methods of collecting, preparing and mounting insects for collections will be taught. Class limited to 30 members.

5 class hours to about May 1; thereafter,
2 class hours. 3 2-hour laboratory periods, credit, 5.

Professor Fernald.

50. **I.** Pests of Special Crops. — For juniors; seniors may elect. For students not majoring in entomology. The laboratory work is largely individual in this term. Accordingly, students majoring in subjects other than entomology, but who desire a more complete knowledge of the insects connected with their own major line of work, can obtain it here. A student majoring in floriculture, for example, will devote his laboratory time to a careful study of the insects injuring floricultural crops, learning how to recognize them and their work in their different stages, and the best methods for their control. Courses of this kind are available on the insects attacking field crops, market-garden crops, tree fruits, small fruits, shade trees and shrubs, flowers, forest trees, the domesticated animals, household pests and man. This work may be continued in the winter term also. (See Course 51, **II.**)

3 2-hour laboratory periods, credit, 3.

Professor Fernald.

Prerequisite, Entomology 26 or 28.

51. **II.** Pests of Special Crops. — As stated in Course 50, **I.** For students not majoring in entomology. Those who were not able to take Entomology 50 in the fall may take it here. Those who took Entomology 50 in the fall have an opportunity to continue the work during this term also.

3 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Entomology 26 or 28.

52. **I.** Classification of Insects. — For juniors specializing in entomology. Laboratory work on the identification and classification of insects of various groups.

2 2-hour laboratory periods, credit, 2.
Assistant Professor Alexander.

Accompanying Entomology 53.

53. **I.** Insect Morphology. — For juniors specializing in entomology and for other juniors or seniors having the prerequisite. The lectures treat of the external and internal anatomy of insects, particularly those parts used in identification, a knowledge of which is needed, in the accompanying Course 52. In the laboratory the external anatomy of the most important groups is studied, emphasizing the characters used in learning the names of insects, and to teach the methods of using analytical keys.

2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor Crampton.

Prerequisite, Entomology 26 or 28.

54. **I.** Insecticides and their Application. — For juniors; seniors may elect. Lectures on the composition, preparation and methods of application of Insecticides.

2 class hours. Credit, 2.
Professor Fernald.

Prerequisite, Entomology 26 or 28.

55. **II.** Continuation of Course 52, one-half term. Insects and their relation to disease, one-half term.

4 2-hour laboratory periods, credit, 4.
Professors Crampton and Alexander.

56. **II.** Pests of Special Crops. — For juniors majoring in entomology. Individual laboratory work on the most important insect pests of this country, and the preparation and presentation of bulletin material on them.

3 2-hour laboratory periods, credit, 3.
The Department.

57. **III.** Classification of Insects. — Continuation of Course 55.

2 2-hour laboratory periods, credit, 2.
Professor Alexander.

75. **III.** Forest and Shade-tree Insects. — For juniors; seniors may elect. The lecture work deals with the principles and methods of controlling insects which attack forests and forest products, shade trees, etc. The laboratory periods are devoted to a study of the more important species, their identification, biology and specific control measures. Field work supplements laboratory study if time permits. One entire Saturday for field excursion also required.

1 class hour. 3 2-hour laboratory or field periods, credit, 4.
Assistant Professor Alexander.

Prerequisites, Entomology 26 or 28; 52 and 53 desirable.

76. **I.** Advanced Entomology. — For seniors. Studies on insect bionomics; scale insects, their structure, habits, methods of mounting, identification, etc.;

studies of the animals not insects with which entomologists are expected to deal.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Professors Crampton and Alexander.

Prerequisite, Entomology 55.

77. **II.** Advanced Entomology. — For seniors. Studies of the life history, habits and methods of control of the important insect pests of the United States; recognition tests of these pests and an examination of the literature on them; methods of bulletin preparation.
3 2-hour laboratory periods, credit, 3.
Assistant Professor Alexander.

Prerequisite, Entomology 76.

78. **III.** Advanced Entomology. — For seniors. Classification of insects and of their early stages; principles of classification, the use of literature on entomology and the preparation of bibliographies and indices; the enemies of insects.
1 class hour. 3 2-hour laboratory or field periods, credit, 4.
Professors Fernald, Crampton and Alexander.

Prerequisite, Entomology 77.

90. **II.** Evolution. — For juniors; seniors may elect. In order to demonstrate the universal scope and operation of the laws of evolution, the course includes a brief sketch of the probable origin and evolution of matter as viewed in the light of modern physical and chemical research; the evolution of the solar system, leading to the formation of the earth; the changes in the earth, preparatory to the production of life; the physical and chemical basis of life; the probable steps in the formation of living matter, and the theories concerning it; the evolution of living things; the developmental history of man, and of the races of mankind; the evolution of human intelligence, languages, culture, institutions, etc., and man's probable future in the light of his past development. Especial consideration is given to the factors of evolution, the basic principles of heredity, variation and similar topics, with particular reference to their application to human welfare; and the recent contributions in the field of entomology to the advancement of our knowledge of these fundamental principles are briefly reviewed.
3 class hours. Credit, 3.
Professor Crampton.

Courses in Beekeeping.

65. **III.** Introductory Beekeeping. — For juniors. A detailed study of the normal behavior of the honey bee and the colony as a whole, followed by a study of such practical work of the apiary as is carried on in spring and summer. In so far as possible the laboratory work parallels the lecture work, and both are made to follow the seasonal processes of the colony. Spring management, swarm control and the production and care of the honey crop are covered thoroughly. The course is designed to meet the needs of the horticulturist as well as those of the honey producer, and should be followed by Course 85, I.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Cassidy.

85. **I.** Introductory Beekeeping. — For seniors. A continuation of Course 65 and a completion of the beekeeping year. Fall management, preparation for winter and wintering are studied in detail in lectures and laboratory work. Original problems for student solution. It is highly advisable for those taking Course 65 to take Course 85, and thus complete the annual cycle of beekeeping activity.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Cassidy.

86. **III.** Advanced Beekeeping. — For seniors. A study of the special problems with which the beekeeper deals. The diagnosis and control of the various bee diseases, production of wax, sources of nectar, honey, bee anatomy

and physiology, and marketing of the crop are some of the principal topics discussed. The course is designed for those who intend going into honey production either as a principal occupation or as a side line. Field trips to commercial apiaries; laboratory practice in queen rearing.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor CASSIDY.

Mathematics and Civil Engineering.

Professor OSTRANDER, Professor MACHMER, Assistant Professor MOORE, Mr. SHUMWAY.

The work of the freshman year is required. It is intended to furnish the necessary drill and groundwork needed for many of the scientific and practical courses of other departments. Thoroughness and accuracy are insisted upon. The advanced work in mathematics is taught from a practical standpoint, and many of its applications to other subjects are given. The courses in surveying and civil engineering are given to furnish the groundwork for a professional career. Special emphasis is given to the subjects bearing on highway construction and maintenance.

For drawing, a room on the north side is used for the draughting. It has draughting tables, T squares, scales, etc., for twenty students. Vernier protractors, parallel rules and steel T squares are available for precise work. A small room is devoted to blueprinting.

In surveying, the department has a considerable number of chains and tapes, two railroad compasses, a builder's level, two dumpy levels, two Y levels and two old levels used for teaching the adjustments. Six transits are available for student use. Two are provided with solar attachments. An omnimeter with vernier reading to ten seconds is available for geodetic work. A hand level, mining aneroid barometer, and prismatic compass are provided for reconnoissance work. A set of Gilmor's needles and a Fairbanks' machine are used for cement testing.

Required Courses.

1. **I.** HIGHER ALGEBRA. — For freshmen. A brief review of radicals, quadratic equations, ratio and proportion, and progressions; graphs, binomial theorem, undetermined coefficients, summation of series, variation, continued fractions, determinants, permutations and combinations, logarithms, theory of equations. Reitz and Crathorne's "College Algebra."
4 class hours. Credit, 4.
Professors MACHMER, MOORE and Mr. SHUMWAY.

2. **II.** HIGHER ALGEBRA. — As stated under Course 1. Required of all who present solid geometry for entrance.
3 class hours. Credit, 3.
Professors MACHMER, MOORE and Mr. SHUMWAY.

3. **II.** SOLID GEOMETRY. — For freshmen. Theorems and exercises on the properties of straight lines and planes, dihedral and polyhedral angles, prisms, pyramids and regular solids; cylinders, cones and spheres; spherical triangles and the measurement of surfaces and solids. Wentworth and Smith's "Solid Geometry." Required unless accepted for admission.
3 class hours. Credit, 3.
Professors MACHMER, MOORE and Mr. SHUMWAY.

4. **II.** MENSURATION AND COMPUTATION. — For freshmen. A review of methods of computation, with special emphasis on short and abbreviated processes, together with methods of checking computations and of forming close approximations; use of slide rule. Also the graph, mensuration of plane and solid figures, weights and measures and elementary mechanism. Numerous practical problems are selected from such subjects as the following: the mathematics of woodworking; rough lumber; general construction; forestry methods in heights of trees; pulleys,

belts and speeds; power and its transmission; dairying; agronomy; computation of areas from simple measurements.
2 class hours. Credit, 2.
Professor MACHMER and Mr. SHUMWAY.

5. **III.** PLANE TRIGONOMETRY. — For freshmen. The trigonometric functions as lines and ratios; proofs of the principal formulas, transformations; inverse functions, use of logarithms; the applications to the solution of right and oblique triangles; practical applications. Bowser's "Elements of Plane and Spherical Trigonometry."
3 class hours. Credit, 3.
Professors MACHMER, MOORE and Mr. SHUMWAY.

Elective Courses.

26. **II.** PLANE SURVEYING. — For sophomores; juniors and seniors may elect. The elements of the subject, including the adjustment and use of the usual instruments. Textbook and lectures.
3 class hours. Credit, 3.
Professors OSTRANDER and MOORE.

27. **III.** PLANE SURVEYING. — For sophomores; juniors and seniors may elect. As stated under Course 26. Includes field work.
3 2-hour laboratory periods, credit, 3.
Professors OSTRANDER and MOORE.
Prerequisite, Mathematics 26.

50. **I.** ANALYTIC GEOMETRY. — For juniors; seniors may elect. A discussion of the geometry of the line, the circle, conic sections, and the higher plane curves. Fine and Thompson's "Co-ordinate Geometry."
3 class hours. Credit, 3.
Professor MACHMER.
Prerequisites, Mathematics 1, 2, 3 and 5.

51. **II.** DIFFERENTIAL AND INTEGRAL CALCULUS. — For juniors; seniors may elect. A first course in the subject, with some of the more important applications. Granville's "Differential and Integral Calculus."
5 class hours. Credit, 5.
Assistant Professor MOORE.
Prerequisites, Mathematics 1, 2, 3 and 5.

52. **III.** INTEGRAL CALCULUS. — For juniors; seniors may elect. A continuation of Course 51.
5 class hours. Credit, 5.
Assistant Professor MOORE.
Prerequisite, Mathematics 51.

53. **II.** ELEMENTARY STRUCTURES. — For juniors; seniors may elect. An elementary course in roofs and bridges. Textbook and lectures.
3 class hours. 1 2-hour laboratory period, credit, 4.
Professor OSTRANDER.

75. **I.** HYDRAULICS AND SANITARY ENGINEERING. — For seniors; juniors may elect. Hydrostatics, theoretical hydraulics, orifices, weirs, pipes, conduits, water supply, hydraulic motors, sewers and sewage treatment. Textbook and lectures.
5 class hours. Credit, 5.
Professor OSTRANDER.

76. **I.** MATERIALS OF CONSTRUCTION. FOUNDATIONS AND MASONRY CONSTRUCTION. — For seniors; juniors may elect. Textbook and lectures.
5 class hours. Credit, 5.
Professor OSTRANDER.

77. **II.** Roads and Railroads. — For seniors; juniors may elect. Topographic and higher surveying, highway construction, earthwork, pavements and railroad construction. Textbook and lectures.

3 class hours. Credit, 3.

Professor Ostrander.

78. **III.** Roads and Railroads. — For seniors; juniors may elect. As stated under Course 77.

3 2-hour laboratory periods, credit, 3.

Professor Ostrander.

Prerequisite, Mathematics 77.

Microbiology.

Professor Marshall, Assistant Professor Bradley, Mr. Mortensen, Miss Garvey.

Three objectives are sought in the arrangement of the courses following: (1) Introductory courses (50 and 51) needed in the general training of every college student. (2) An introductory course followed by a specific course (as 80, 81, 82, 83), necessary to every student engaged in the Division of Agriculture, with which the specific course deals. (3) Introductory courses (50 and 51) followed by Courses 52, 75, 76 and 81, preparatory for students who are aiming to specialize in agricultural microbiology. (Courses 75, 76 and 81 are adapted to those having Courses 50 and 51 only, and are also adapted to those majoring in microbiology.)

The microbiological work is carried on in a building especially designed for it. There are 4 class laboratory rooms, 8 private laboratory rooms, 1 lecture room, 5 incubator rooms, 3 sterilizing rooms, 3 hood rooms, 3 washing rooms, 3 inoculating rooms, 3 weighing rooms, an animal room, a photographic and dark room, a sub-basement refrigerator room, a library and 4 office rooms.

The class laboratory rooms are so arranged that individual desks are available for student use. Hot and cold water and gas connections are convenient for each desk; high-pressure steam and electric connections are also available. The building is well lighted and of sanitary construction; all the walls are of brick, and the building is fireproof.

The library is equipped with such books and current periodicals as are useful in the conduct of bacteriological work and investigations. Twenty-four scientific magazines are available regularly.

There are incubators, both electric and gas, hot-air sterilizers, ordinary steam sterilizers, autoclaves, an inspissator, blood-testing apparatus, vacuum apparatus, air-pressure apparatus, shaker, grinder, centrifugal machines, a water still of 5 gallons per hour capacity, Hoskin's combustion furnace, a balopticon, complete microphotographic equipment, microscopes, microtome, and such other apparatus, glassware and chemicals as are needed for extensive and intensive work.

Required Course.

30. **III.** Elementary Microbiology. — Required of sophomores majoring in the agricultural division. Designed to make micro-organisms real and significant to the student who seeks some knowledge of their activities. An attempt is made to place them among living organisms, to demonstrate their wide distribution in nature and to indicate what they do. Some of the essential methods of control and propagation are reviewed. Owing to the time limit, this course may be regarded as an introductory survey course only.

6 laboratory hours, credit, 3.

Mr. Mortensen.

33. **III.** Physiology. — For sophomores. Offered for the year 1925–26.

3 class hours. 1 2-hour laboratory period, credit, 4.

Miss Garvey.

Elective Courses.

50. **I, II** and **III.** Introductory and General Microbiology. — For juniors; seniors may elect. Aims to provide elementary basis for microbial studies and interpretation, to enable students to pursue special pertinent courses

which will serve as supports in practical electives or majors, and to furnish students with such material as will be valuable in understanding public health problems.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor Marshall and Mr. Mortensen.

51. **II** and **III**. Morphological, Cultural and Physiological Microbiology. — For juniors; seniors may elect. Types of micro-organisms, technic of handling, methods of culture and functions of micro-organisms are considered. This course is fundamental to all advanced and extended microbiological studies.
10 laboratory hours, credit, 5.
Mr. Mortensen.
Prerequisite, Microbiology 30 or 50.

52. **III**. Advanced Morphological, Cultural and Physiological Microbiology. — For juniors; seniors may elect. Prepares for a more intimate knowledge of microbiological agricultural problems. To accomplish this object it is necessary to provide more advanced technique and methods of culture, together with a more extensive knowledge of micro-organisms and their functions.
10 laboratory hours, credit, 5.
Assistant Professor Bradley.
Prerequisite, Microbiology 51.

60. **I**. Public Health. — For juniors; seniors may elect. Considers the relation of the human body to its environment in the maintenance of health and the production of disease. This study is based upon human anatomy and physiology. The individual, as a member of society, governed by natural laws, is also of fundamental importance. A knowledge and an interpretation are sought of the usual agencies connected with health and disease, as air, water, sewage, dairy products, foods, drugs, carriers, vaccines and their prophylactic means, biological products as diagnostic and remedial materials and public health practices now recognized. Diseases of public health significance are reviewed, their control considered and their social values discussed.
3 class hours. Credit, 3.
Professor Marshall and Miss Garvey.

61. **II**. Public Health. — For juniors; seniors may elect. As stated under Course 60.
3 class hours. Credit, 3.
Professor Marshall and Miss Garvey.

62. **III**. Public Health. — For juniors; seniors may elect. As stated under Course 60.
3 class hours. Credit, 3.
Professor Marshall and Miss Garvey.

75. **II**. Agricultural Microbiology. — For seniors; juniors may elect. This general comprehensive course is designed to cover in an elementary manner those subjects only which confront the student of general agriculture, — the microbiological features of air, water, sewage, soil, dairy, fermentations, food, vaccines, antisera, microbial plant infections, methods and channels of infections, immunity and susceptibility, microbial infections of man and animals, methods of control or sanitary and hygienic practices.
10 laboratory hours, credit, 5.
The Department.
Prerequisite, Microbiology 51.

76. **III**. Agricultural Microbiology. — For seniors; juniors may elect. As stated under Course 75.
10 laboratory hours, credit, 5.
The Department.
Prerequisite, Microbiology 75.

80. **II.** Soil Microbiology. — For seniors; juniors may elect. Such subjects as the number and development of micro-organisms in different soils; the factors which influence their growth, food, reaction, temperature, moisture and aeration; the changes wrought upon inorganic and organic matter in the production of soil fertility, ammonification, nitrification and dentrification; fixation of nitrogen symbiotically and non-symbiotically; methods of soil inoculation receive attention.

10 laboratory hours, credit, 5.
Assistant Professor Bradley.

Prerequisite, Microbiology 51.

81. **I.** Hygienic Microbiology. — For seniors; juniors may elect. An attempt is made to select certain material which is basic to public hygiene and sanitation, as applied to man and animals. The microbiology of water supplies, food supplies, vaccines, antisera or antitoxins; the channels by which micro-organisms enter the body, the influence of body fluids and tissues upon them, body reactions with micro-organisms (susceptibility and immunity); the micro-organisms of some of the most important infectious diseases, methods of control, including disinfectants and disinfection, antiseptics, antisepsis and asepsis, are treated.

10 laboratory hours, credit, 5.
Assistant Professor Bradley.

Prerequisite, Microbiology 51.

82. **I.** Dairy Microbiology. — For seniors; juniors may elect. Special emphasis is placed upon milk supplies. The microbial content of milk, its source, its significance, its control; microbial taints and changes in milk; groups or types of organisms found in milk; milk as a carrier of disease-producing organisms; the value of straining, aeration, clarification, centrifugal separation, temperature, pasteurization; the abnormal fermentations of milk; bacteriological milk standards and their interpretation; ripening of milk and cream; the bacterial content of butter; a passing survey of the microbiology of cheeses; a study of special dairy products, as ice cream, condensed milk, artificial milk drinks (the products of microbial actions), represents a list of topics considered.

10 laboratory hours, credit, 5.
Professor Marshall and Miss Garvey.

Prerequisite, Microbiology 51.

83. **III.** Food Microbiology. — For seniors; juniors may elect. A study of the principles of food preservation, and food preservation by means of drying, canning, refrigerating and addition of chemicals, is pursued. Food fermentations, as illustrated by bread, pickles, sauerkraut, ensilage, vinegar, wine, etc., are examined. Decomposition of foods, as may be seen in meat, oysters, fish, milk, etc., as well as diseased and poisonous foods, receive consideration. Contamination of food supplies by means of water, sewage, handling, exposure, diseased persons, etc., is of especial significance, and is demonstrated by laboratory exercises. Laboratory inspection of foods is now a subject of great import and is given attention.

10 laboratory hours, credit, 5.
Professor Marshall and Miss Garvey.

Prerequisite, Microbiology 51.

Physics.

Professor Powers, Mr. Alderman.

The fundamental and basic importance of the laws and phenomena of physics makes necessary no explanation of the introduction of this subject into the curriculum of an agricultural college. The logical development of the subject emphasizes the importance of physics as a science in itself. Special emphasis is laid, however, on the correlation of the principles studied with the sciences of agriculture, botany, chemistry and zoölogy, thus furnishing an extra tool by use of which the student's work in all the subjects may be more effective.

In Courses 25, 26 and 27 the subject-matter is presented with the idea of its special application primarily in the work in agriculture and general science. The full year's work is required of all students continuing work specifically in the Division of Science. Course 25 is required of all students. The subject-matter is especially selected and arranged for its practical application rather than its theoretical development. Courses 50, 51 and 52 are advised for students in chemistry, general biology, microbiology and general science. The subject-matter is selected, and the courses developed, with the idea of making the student proficient in laboratory manipulation. Sufficient theory is given in connection with the work to enable the student to apply the knowledge and practice thus gained in the department indicated above.

The department has at its command a building on the east campus, containing a general lecture room and laboratory for sophomore work, a laboratory for junior work, and in the basement one small laboratory for quantitative work in light measurement. There is also in the basement a fairly well-equipped shop for the repair and construction of apparatus used in the department work. The usual apparatus for the demonstration in the lecture room is in the possession of the department.

Required Courses.

25. **I.** General Physics. — For sophomores. Mechanics of solids and fluids. This course includes statics, with equilibrium of rigid bodies, work, energy and friction; kinetics, considering rectilinear motion and motion in a curved path; harmonic motion; rotation of rigid bodies, including kinematics of rotation; liquids and gases, with properties of fluids at rest and in motion; properties of matter and its internal forces, including elasticity, capillarity, surface tension.
3 class hours. 1 2-hour laboratory period, credit, 4.
Professor Powers and Mr. Alderman.

26. **II.** Electricity and Magnetism. — For sophomores; juniors and seniors may elect. Includes such subject-matter as magnetism, electrostatics, electric currents with their production, chemical, heating and mechanical effects; battery cells, measurement of voltage, current flow and resistance, motors and generators.
3 class hours. 1 2-hour laboratory period, credit, 4.
Professor Powers and Mr. Alderman.

27. **III.** Heat and Light. — For sophomores; juniors and seniors may elect. Thermometry, expansion, colorimetry and specific heat, transmission of heat, changes of state, radiation and absorption. Wave theory of light, optical instruments, analysis of light, color, interference, diffraction, polarization.
3 class hours. 1 2-hour laboratory period, credit, 4.
Professor Powers and Mr. Alderman.

Elective Courses.

50. **I.** 51. **II.** 52. **III.** Experimental Physics. Heat, Light, Electricity and Magnetism. — For juniors; seniors may elect. This course consists of a series of physical measurements in the laboratory, accompanied by lectures. The lectures deal chiefly with the methods and principles involved in the laboratory work. High-grade instruments of precision are employed in the laboratory work, and the student is expected to acquire some ability to make accurate observations. The primary object of the course is to develop in the student scientific habits of thinking by direct personal observation of physical phenomena.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Professor Powers.

Prerequisite, Physics 27.

55. **III.** Analytical Mechanics. — For juniors; seniors may elect. An introduction to the application of the calculus to the mechanics of solids; statics and kinetics of rigid bodies; elasticity; vector analysis. For students who have taken or are taking Mathematics 52.
3 class hours. Credit, 3.
Mr. Alderman.

75. **I.** 76. **II.** 77. **III.** Theory of Light. — For seniors. Propagation of light, formation of optical images, photography, optical instruments, interference, diffraction, spectroscopy, optical phenomena of the atmosphere, polarization and double refraction, magneto-optics, photo-electricity, radiation, electromagnetic waves, X-rays and crystal structure, electron theory, principle of relativity. Not given 1925–26.
3 class hours. Credit, 3.
Professor Powers.

Prerequisite, Mathematics 51.

Veterinary Science and Animal Pathology.

Professor Gage, Assistant Professor Lentz.

The courses in veterinary science have been arranged to meet the needs (1) of students who propose following practical agriculture; (2) of prospective students of human and veterinary medicine; and (3) of teachers and laboratory workers in the biological sciences.

The department occupies a modern laboratory and hospital stable, built in accordance with the latest principles of sanitation. Every precaution has been taken in the arrangement of details to prevent the spread of disease, and to provide for effective heating, lighting, ventilation and disinfection.

The main building contains a large working laboratory for student use, and several small private laboratories for special work. There is a lecture hall, a museum, a demonstration room, a photographing room and a workshop. The hospital stable contains a pharmacy, an operating hall, a post-mortem and dissecting room, a poultry section, a section for cats and dogs, and 6 sections, separated from each other, for horses, cattle, sheep and swine. The laboratory equipment consists of a dissectible Auzoux model of the horse and Auzoux models of the foot and the leg, showing the anatomy and the diseases of every part. The laboratories also have modern, high-power microscopes, microtomes, incubators and sterilizers, for work in every department of veterinary science, including pathology, serology and parasitology. There are skeletons of the horse, the cow, the sheep, the dog and the pig, and a growing collection of anatomical and pathological specimens. The lecture room is provided with numerous maps, charts and diagrams.

Elective Courses.

50. **II.** Veterinary Hygiene and Stable Sanitation. — For juniors; seniors may elect. Familiarizes students with the relation of water, food, air, light, ventilation, care of stables, disposal of excrement, individual hygiene, etc., to the prevention of disease in farm animals.
5 class hours. Credit, 5.
Assistant Professor Lentz.

53. **I.** Gross Veterinary Anatomy. — For juniors; seniors and graduate students may elect. The detailed study of the skeleton is followed by dissection of the muscular system and the study of joints.
2 3-hour laboratory periods, credit, 3.
The Department.

54. **II.** Gross Veterinary Anatomy. — For juniors; seniors and graduate students may elect. The continuation of Veterinary 53, consisting of dissection

and study of the circulatory, nervous, digestive, respiratory, and genito-urinary systems.

2 3-hour laboratory periods, credit, 3.
The DEPARTMENT.

Prerequisite, Veterinary 53.

75. **I.** COMPARATIVE (VETERINARY) ANATOMY. — For seniors; juniors may elect. The anatomy of the horse is studied in detail, and that of other farm animals, particularly the ox. This course is essential for those students wishing to elect Course 77. It is a lecture and demonstrational course and open to all students interested. It is not a course in dissection anatomy.

5 class hours. Credit, 5.
Assistant Professor LENTZ.

76. **II.** GENERAL VETERINARY PATHOLOGY. — For seniors; juniors may elect. Fundamental, general, pathological conditions, as for example, inflammation, fever, hypertrophy, atrophy, etc., a knowledge of which is essential in prevention, diagnosis, and treatment of disease, are studied. The course in pathology is followed by a brief consideration of materia medica, therapeutic measures, and poisonous plants.

5 class hours. Credit, 5.
Assistant Professor LENTZ.

77. **III.** APPLIED GENERAL PATHOLOGY. — For seniors; juniors may elect. This course is a continuation of Course 76. Particular attention is given to the etiology, the pathogenesis and the prophylaxis of the communicable and non-communicable diseases of the different species of domesticated animals. Lectures and demonstrations.

5 class hours. Credit, 5.
Assistant Professor LENTZ.

Prerequisites, Veterinary 75 or Veterinary 78, 79 and 80.

78. **I.** ESSENTIALS OF GENERAL PATHOLOGY. — For seniors; juniors may elect. Introduces students to some of the essential anatomical, histological and general physiological phenomena essential to the understanding of some of the simple general pathological conditions found in domestic animals. Some of the common methods of diagnosis are considered in the laboratory. The various chemical and biological reactions and tests are presented from the standpoint of pure science, showing applications of chemistry and biology. The course serves to educate liberally and stimulate in the student of agriculture the appreciation of some of the methods used in animal pathology for detecting and controlling some of the more common animal diseases. Lectures, demonstration and laboratory work.

2 3-hour laboratory periods, credit, 3.
Professor GAGE.

79. **II.** ESSENTIALS OF GENERAL ANIMAL PATHOLOGY. — For seniors; juniors may elect. A continuation of Course 78, devoted to a study of some of the common pathological conditions by means of prepared sections, the aim being to demonstrate to the student abnormal animal histological structures commonly observed when material from various cases of animal diseases is prepared for microscopical study. Some of the biological products used in protecting animals against disease are considered.

2 3-hour laboratory periods, credit, 3.
Professor GAGE.

Prerequisite, Veterinary 78.

80. **III.** Essentials of General Animal Pathology. — For seniors; juniors may elect. As stated in Courses 78 and 79.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

Prerequisite, Veterinary 79.

85. **I.** Avian Pathology. — For seniors; juniors may elect. A course in poultry diseases. The object is to present information concerning the common diseases of poultry, their etiology, diagnosis and prevention. Consists of a systematic study of the diseases of the alimentary tract, liver and abdominal region, followed by a study of the diseases of the respiratory system, circulation and kidneys. The important disease-producing external and internal parasites are considered; also diseases of the skin and reproductive organs. Lectures and demonstrations.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

86. **II.** Avian Pathology. — For seniors; juniors may elect. As stated under Course 85, also devoted to the study of some of the special diseases of poultry. Recent methods used in the control of these diseases are considered an opportunity offered the student for demonstrating various disease processes by means of prepared slides. Lectures, demonstations and laboratory work.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

Prerequisite, Veterinary 85.

87. **III.** Avian Pathology. — For seniors; juniors may elect. As stated under Courses 85 and 86.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

Prerequisite, Veterinary 86.

Zoölogy and Geology.

Professor Gordon, Mr. Ring.

The facts and principles of the sciences of zoölogy and geology have important applications in industry and the arts, and with those of their sister sciences form a body of knowledge of value and interest with which the educated man finds it necessary to gain a close familiarity. The elective courses in this department stand as offerings to students who wish to supplement their work in other departments, or who, for any reason, wish to enlarge their knowledge in either zoölogy or geology. Students are encouraged to consult the department about any courses which may be available to them, and which might prove necessary or helpful for any line of work they may wish to follow.

The building occupied jointly by the department of entomology and the department of zoölogy and geology has for the work in zoölogy and geology laboratories equipped with gas, compound microscopes and the accessories needed for study in these subjects. The Zoölogical Museum has a representative collection of several thousand specimens of animals, and is drawn upon for material illustrating the various courses.

Zoölogy.

Required Course.

26. **II.** General Principles of Zoölogy. — For sophomores. An introductory course dealing with the basic features of animal structure, functions of organs, relations of animals to each other and some of the important principles and doctrines that have grown out of the study of animals.

2 class hours. 2 2-hour laboratory periods, credit, 4.
The Department.

50. **I.** Synoptic Invertebrate Zoölogy; the Annelids and the Arthropods. — For juniors; seniors may elect. A study of the classes and orders of the annelid worms and the arthropods, exclusive of insects.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

51. **II.** Synoptic Invertebrate Zoölogy; the Molluscs and the Echinoderms. — For juniors; seniors may elect. A study of the classes and orders of the molluscs and echinoderms.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

52. **III.** Synoptic Invertebrate Zoölogy; Miscellaneous Invertebrate Phyla. — For juniors; seniors may elect. A study of various selected phyla of the non-vertebrated animals. For those who have not taken either or both of the preceding courses in synoptic invertebrate zoölogy this course may include representatives of the different phyla named therein.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

53. **I.** Elements of Microscopic Technique. — For juniors; seniors may elect. Gives the usual methods of preparing material for microscopic examination, including fixing, embedding, sectioning and differentiation by stains. May be supplemented by a study of selected normal tissues in connection with their physiological properties.
3 2-hour laboratory periods, credit, 3.
The Department.

75. **I.** Special Zoölogy. — Juniors, seniors and graduates may apply for such special work as they are qualified to undertake.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

76. **II.** Special Zoölogy. — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

77. **III.** Special Zoölogy. — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

79. **III.** Ornithology. — For juniors; seniors may elect. The taxonomic characters, distribution and habits of birds.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

Geology.

52. **III.** General Geology. — For juniors; seniors may elect. A course in the various aspects of physical geology, dealing with materials of the earth's crust; their nature, origin and arrangement and the changes which they undergo.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor Gordon.

DIVISION OF THE HUMANITIES.

Professor Lewis.

Economics and Sociology.

Professor Mackimmie, Professor Lewis, Professor Sims.[1]

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

The courses in economics and sociology are planned with the purpose of giving the student that knowledge and understanding of the important factors and problems in this field of study and life which every active citizen and educated man ought to have.

Required Course.

25. **I.** Introduction to Economic Principles and Problems. — For sophomores. For description of course see Course 50, **I.**
5 class hours. Credit, 5.
Professor Mackimmie.

Elective Courses.

26. **II.** Civilizations, Ancient and Modern. — For sophomores; juniors and seniors may elect. The evolutionary origin and history of man; characteristics of primitive man, departure from the animal status and beginnings of civilization; origin and development of industries, arts and sciences; the evolution of languages, warfare, migrations and social institutions; a study of the powerful natural and human forces that have brought man from the early stages to modern development; characteristic features of the leading civilizations and races of ancient and modern times; beneficial and dangerous factors in American life in view of the history of human civilization. Not given 1925–26.
5 class hours. Credit, 5.

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50. **I.** Introduction to Economic Principles and Problems. — For juniors and seniors. Definitions of economic terms, such as wealth, capital, value, etc.; factors of production, exchange and consumption; principles of economic production, supply and demand, diminishing returns, division of labor, productive organization, concentration of capital and labor, trust and monopoly problems, public control of production and distribution; principles of exchange, theories of value, money and its problems; international trade, tariff and free trade theories, American merchant marine, reciprocity, and trade treaties; forms of income, wages, interest, rent, profits and the forces which govern them; principles of spending, economy, luxury, conservation of individual and national resources; principles and agencies for saving, investments, banks, building associations, insurance of all kinds; schemes for social organization; socialism, communism, industrial democracy. Textbook and readings.
5 class hours. Credit, 5.
Professor Mackimmie.

51. **II.** Business and Industry. — For juniors and seniors. The forms, organization, administration and labor problems of business. Methods of organizing, financing and administering corporations and partnerships; forms of business administration, wholesaling, jobbing, retailing, advertising, credits and collections; system of industrial remuneration for wage earners, co-operation and preserving industrial peace; problems concerned with protective legislation for workmen and employers, sweated industries, prison labor, child labor and industrial education.
5 class hours. Credit, 5.
Professor Mackimmie.

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[1] Absent on leave.

52. **III.** Public Finance, Taxation, Money and Banking. — For juniors and seniors. Systems and problems of taxation as they are found in Europe and America; objects for spending public revenue; public debts and methods of organizing them; systems of money and currency problems of America; types, methods and functions of banks; economic and financial crises and depressions in the United States; modern war finance. Readings and lectures.
5 class hours. Credit, 5.
Professor Mackimmie.

75. **I.** Social Institutions and Social Reforms. — For seniors; juniors by permission. Social institutions, such as the family, the State, property, religions; and such current problems as eugenics, race suicide, divorce, crime and delinquent classes, prison reform, prevention and treatment of dependents and defectives, poverty, its causes and preventions; constructive modern social reform movements for insurance of wage earners, protection of childhood, assurance of safety, health and play time for all classes. The correctional and charitable institutions of Massachusetts are studied in considerable detail.
5 class hours. Credit, 5.
Professor Sims.

History and Government.

Professor Lewis, Professor Mackimmie.

Required Courses.

25. II. American Government. — For sophomores. A study of the structure and operation of the machinery of our government; also a study of the history of its development from its inception to the present day.
3 class hours. Credit, 3.
Professor Lewis.

27. **III.** Citizenship. — For sophomores. A course designed to acquaint the student with the most important and immediate problems of government — national, State and local — so that as a citizen he may make an intelligent contribution towards their solution. Lectures and discussions.
2 class hours. Credit, 2.
Professor Lewis.

Elective Courses.

50. **I.** Government. — For juniors and seniors. Forms and working methods of the government of Great Britain, Germany, France, Russia, Switzerland, New Zealand and Canada; historic types and theories of government; forms and methods of Federal, State and local governments in America; progress and problems of democracy and new reform movements in organization and administration; new tendencies towards social legislation and extension of governmental control.
3 class hours. Credit, 3.
Professor Mackimmie.

51. **II.** Modern European History. — For juniors and seniors. The modern history of the principal countries of Europe, especially the great movements and revolutions that developed the nations up to the present generation.
3 class hours. Credit, 3.
Professor Mackimmie.

52. **III.** European History Since 1870. — For juniors and seniors. The Franco-Prussian War and the formation of the German Empire, the unification of Italy, the Third French Republic, European Expansion in the East, the Russo-Japanese War, and the origin, events and probable results of the War of 1914. While a continuation of Course 51, this course will be complete in itself, and may be elected by those who have had no history training. Its aim is to provide the basis for an understanding of present-day conditions, and for an intelligent participation in world affairs.
3 class hours. Credit, 3.
Professor Mackimmie.

Languages and Literature.

Professor Lewis, Professor Patterson, Professor Ashley, Professor Julian, Assistant Professor Prince, Assistant Professor Rand, Miss Goessmann, Mr. Jackson, Mr. Halliday, Mr. Keller.

English.

Required Courses.

1. **I.** 2. **II.** 3. **III.** English. — For freshmen. Composition. Intended to teach straight thinking, sound structure, clear and correct expression. Lectures, recitations, theme writing and conferences.
3 class hours. Credit, 3.
Professors Patterson, Prince, Rand and Mr. Jackson.

25. **I.** 26. **II.** 27. **III.** English. — For sophomores. A general reading course in English literature.
2 class hours. Credit, 2.
Professor Patterson and Miss Goessmann.

28. **I.** 29. **II.** 30. **III.** English. — For sophomores. English composition, oral and written.
1 class hour. Credit, 1.
Professors Patterson, Prince, Rand and Mr. Jackson.

Elective Courses in English Language and Literature.

50. **I.** English Poetry of the Romantic Period (1925–26). — Alternates with Course 53. For juniors; seniors may elect. A course in history, appreciation and understanding. Some of the writers studied are Gray, Goldsmith, Burns, Scott, Wordsworth, Coleridge, Byron, Keats and Shelley.
3 class hours. Credit, 3.
Professor Patterson.

51. **II.** English Poetry in the Nineteenth Century (1926–27). — Alternates with Course 54. For juniors; seniors may elect. In general, this course is like Course 50. Tennyson, Browning, Mrs. Browning, Arnold, Clough, the Rossettis, Morris, Swinburne and others.
3 class hours. Credit, 3.
Professor Lewis.

57. **III.** English Poetry in the Nineteenth Century (1926–27). — Alternates with Course 58. For juniors; seniors may elect. As stated under Course 51.
3 class hours. Credit, 3.
Professor Lewis.

52. **III.** English Writers from Milton to Pope. — For juniors; seniors may elect. A survey course that emphasizes the leading writers, literary currents and the thought of the period. Some of the writers studied are Milton, Dryden, Addison, Swift and Pope.
3 class hours. Credit, 3.
Professor Patterson.

53. **I.** English Prose of the Romantic Period (1926–27). — For juniors; seniors may elect. A course in English prose paralleling Course 50. Some of the writers studied are Goldsmith, Coleridge, Lamb, DeQuincey and Hazlitt.
3 class hours. Credit, 3.
Professor Patterson.

54. **II.** English Prose in the Nineteenth Century (1925–26). — For juniors; seniors may elect. Parallels Course 51. Among the writers considered will be Macaulay, Carlyle, Ruskin, Newman and Arnold.
3 class hours. Credit, 3.
Professor Lewis.

58. **III.** English Prose in the Nineteenth Century (1925–26). — For juniors; seniors may elect. As stated under Course 54. Alternates with Course 57.
3 class hours. Credit, 3.
Professor Lewis.

55. **II.** American Literature. — For juniors; seniors may elect. A course in the chief American prose writers; among those studied being Franklin, Brockden, Brown, Irving, Cooper, Poe, Hawthorne, Amerson, Thoreau, Lowell, Holmes, Parkman.
3 class hours. Credit, 3.
Assistant Professor Prince.

56. **III.** American Literature. — For juniors; seniors may elect. A course in the chief American poets; among those studied being Freneau, Bryant, Poe, Emerson, Longfellow, Whittier, Holmes, Lowell, Whitman, Lanier.
3 class hours. Credit, 3.
Assistant Professor Prince.

60. **I.** The Literature of Rural Life. — For juniors; seniors may elect. A critical and appreciative study of writers, both in prose and poetry, who have interpreted nature from the viewpoint of the lover of country life, and those who have idealized agriculture, horticulture and other rural pursuits, together with those who have upheld as an ideal the development of a rural environment in cities.
3 class hours. Credit, 3.
Miss Goessmann.

61. **II.** The Literature of Rural Life. — For juniors; seniors may elect. As stated under Course 60.
3 class hours. Credit, 3.
Miss Goessmann.

Prerequisite, English 60.

65. **I.** Advanced Composition. — For juniors; seniors may elect. Advanced work in expository writing, based upon specimens by contemporary authors and upon the personal experience of the student. Particular attention is given to organization, diction and style.
3 class hours. Credit, 3.
Assistant Professor Rand.

66. **II.** Advanced Composition. — For juniors; seniors may elect. The preparation of theses and similar manuscripts upon subjects selected by the student. The foundation of this course lies in an orderly accumulation of material followed by an intelligent and readable interpretation of its significance.
3 class hours. Credit, 3.
Assistant Professor Rand.

67. **III.** Advanced Composition. — For juniors; seniors may elect. Work in journalistic and fictional narrative with supplementary reading.
3 class hours. Credit, 3.
Assistant Professor Rand.

75. **III.** Prose Fiction. — The short story or the novel. For seniors; juniors may elect. Readings, reports and discussions. Not offered in 1925–26.
3 class hours or library equivalents. Credit, 3.

79. **II.** Shakespeare. — For seniors; juniors may elect. A cursory survey of the origin and rise of English drama is followed by the reading of about fifteen of Shakespeare's plays, selected to indicate the evolution of the dramatist and to

emphasize the various phases of his art. Every attempt is made to deepen the student's appreciation of the personalities to be found in the plays, and of the beauty of the many memorable poetic passages.
3 class hours. Credit, 3.
Assistant Professor RAND.

80. **III.** MODERN DRAMA. — For seniors; juniors may elect. This course traces the development of English drama from the time of the Restoration to the present day. The purpose of the course is to impart an intelligent and sympathetic interest in the theatre of the Twentieth Century.
3 class hours. Credit, 3.
Assistant Professor RAND.

PUBLIC SPEAKING.

Elective Courses.

50. **I.** ARGUMENTATION. — For juniors; seniors may elect. Presents the fundamental principles of argumentation as applied to oral and written discourse, and develops in the student power to handle argument convincingly and persuasively. Lectures, discussions of leading questions of the day, practice in brief-drawing and the writing of forensics. The course is recommended for those who desire to enter the intercollegiate debates.
3 class hours. Credit, 3.
Assistant Professor PRINCE.

51. **II.** OCCASIONAL ORATORY. — For juniors; seniors may elect. A study of the principles and the practice of formal oratory; the preparation and delivery of one original oration; prescribed reading in oratory. The course is recommended for those who wish to enter the Flint Contest.
3 class hours. Credit, 3.
Assistant Professor PRINCE.

French, Spanish and Music.

Professor ASHLEY, Mr. HALLIDAY.

The aim of the courses in French and Spanish is to give the student a practical knowledge of these languages for the purpose of wider reading and research, to introduce him to some of their treasures in art and science, and through the literature to acquaint him with the people. In the elementary courses as much time as possible is given to oral work, to develop a speaking, as well as a reading, knowledge of the tongue.

FRENCH.

Required Courses.

1. **I.** 2. **II.** 3. **III.** ELEMENTARY FRENCH. — For freshmen; sophomores, juniors and seniors may elect. The essentials of grammar are rapidly taught and will be accompanied by as much reading as possible. Required of freshmen presenting German for entrance who do not continue that language and have not studied French.
3 class hours. Credit, 3.
Professor ASHLEY.

4. **I.** 5. **II.** 6. **III.** INTERMEDIATE FRENCH. — For freshmen; sophomores, juniors and seniors may elect. Training for rapid reading. The reading of a number of short stories, novels and plays; composition, reports on collateral reading from periodicals and scientific texts in the library.
3 class hours. Credit, 3.
Mr. HALLIDAY.
Prerequisite, required of freshmen who present two years of French for entrance and do not take German.

25. **I.** Intermediate French. — For sophomores; juniors and seniors may elect. Training for rapid reading; the reading of a number of short stories, novels and plays; readings from periodicals and scientific texts in the library.
3 class hours. Credit, 3.
Mr. Halliday.

Prerequisites, French 1, 2 and 3.

26. **II.** Intermediate French. — For sophomores; juniors and seniors may elect. As stated under Course 25.
3 class hours. Credit, 3.
Mr. Halliday.

Prerequisite, French 25.

27. **III.** Intermediate French. — For sophomores; juniors and seniors may elect. As stated under Course 25.
3 class hours. Credit, 3.
Mr. Halliday.

Prerequisite, French 26.

28. **I.** Advanced French. — For sophomores; juniors and seniors may elect. A reading course. Balzac's "Eugénie Brandet" and "Le Père Goriot," and other masterpieces of the nineteenth century; Brunetière's "Honoré de Balzac" and Harper's "Masters of French Literature," readings in the library and written reports.
3 class hours. Credit, 3.
Professor Ashley.

Prerequisites, French 4, 5 and 6.

29. **II.** Advanced French. — For sophomores; juniors and seniors may elect. As stated under Course 28.
3 class hours. Credit, 3.
Professor Ashley.

Prerequisites, French 4, 5 and 6.

30. **III.** Advanced French. — For sophomores; juniors and seniors may elect. General view of the history of French literature; Kastner and Atkins' "History of French Literature." Representative works of the important periods. Outside reading.
3 class hours. Credit, 3.
Professor Ashley.

Prerequisites, French 25 and 26, or French 28 and 29.

50. I. Scientific French. — For juniors; seniors may elect. Meets the requirements of individual students and equips them with exact English equivalents for the French scientific terms in their particular science. Word lists of scientific terms are required, and also weekly readings and reports from scientific works in the subject in which they are majoring. Several scientific works are read.
3 class hours. Credit, 3.
Mr. Halliday.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

51. **II.** Scientific French. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Mr. Halliday.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

52. **III.** Scientific French. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Mr. Halliday.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

75. **I.** French Literature. — For seniors; juniors may elect. The object of Courses 75, 76 and 77 is to give an introduction to recent movements in French literature. Course 75 deals with the drama, and plays by Augier, A. Dumas *fils*, Delavigne and other contemporary dramatists.
2 class hours. Credit, 2.
Professor Ashley.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

76. **II.** French Literature. — For seniors; juniors may elect. The novel. Works by Flaubert, the De Goncourts and Zola are read. Written reports are required on outside reading.
2 class hours. Credit, 2.
Professor Ashley.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

77. **III.** French Literature. — For seniors; juniors may elect. Modern criticism. Sainte-Beuve, "Causeries du Lundi" (Harper), and works by Taine and Renan. Reference book, Lanson's "Histoire de la Littérature Française."
2 class hours. Credit, 2.
Professor Ashley.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

Spanish.

Elective Courses.

50. **I.** Elementary Spanish. — For juniors; seniors may elect. Open to other students upon arrangement. Grammar, with special drill in pronunciation; exercises in conversation and composition. Reading from a reader and selected short stories.
3 class hours. Credit, 3.
Professor Ashley.

51. **II.** Elementary Spanish. — For juniors; seniors may elect. As stated in Course 50.
3 class hours. Credit, 3.
Professor Ashley.

Prerequisite, Spanish 50.

52. **III.** Elementary Spanish. — For juniors; seniors may elect. As stated in Course 50.
3 class hours. Credit, 3.
Professor Ashley.

Prerequisite, Spanish 51.

75. **I.** Modern Spanish Authors. — For seniors. Reading from modern Spanish novel and drama. Translation of English into Spanish. Private reading.
2 class hours. Credit, 2.
Professor Ashley.

Prerequisite, Spanish 52.

76. **II.** Modern Spanish Authors. — For seniors. As stated in Course 75.
2 class hours. Credit, 2.
Professor Ashley.

Prerequisite, Spanish 75.

77. **III.** Modern Spanish Authors. — For seniors. As stated in Course 75.
2 class hours. Credit, 2.
Professor Ashley.

Prerequisite, Spanish 76.

Music.

Elective Courses.

50. **I.** History and Interpretation of Music. — For juniors; seniors may elect. History of music among the ancients; medieval and secular music; epoch of vocal counterpoint; development of monophony opera and oratorio; life and works of the greatest representatives of the classical school, — Bach, Händel, Haydn, Gluck and Mozart.
1 class hour. Credit, 1.
Professor Ashley.

51. **II.** History and Interpretation of Music. — For juniors; seniors may elect. A continuation of Course 50. The Romantic school; Beethoven, Schubert, Weber, Mendelssohn, Schumann, Chopin, Berlioz and Liszt; Wagner and the opera.
1 class hour. Credit, 1.
Professor Ashley.

52. **III.** History and Interpretation of Music. — For juniors; seniors may elect. The Modern school and Modern composers.
1 class hour. Credit, 1.
Professor Ashley.

German.

Professor Julian, Mr. Keller.

German.

The courses in German are intended to give the student a reading knowledge of the language and to introduce to him some of the masterpieces of German literature. To the student interested in pursuing advanced reading in scientific German, opportunity is given to do corollary reading in his major subject, in collaboration with the head of that department.

Required Courses.

1. **I.** 2. **II.** 3. **III.** Elementary German. — For freshmen; sophomores, juniors and seniors may elect. Grammar, composition and reading. Especial attention is given to oral work in German and to translation of English into German. Required of those presenting French for entrance who do not continue that language and have not studied German.
3 class hours. Credit, 3.
Professor Julian and Mr. Keller.

4. **I.** 5. **II.** 6. **III.** Intermediate German. — For freshmen; sophomores, juniors and seniors may elect. Selected works of Schiller, Heine and Goethe. Grammar review and advanced prose composition.
3 class hours. Credit, 3.
Mr. Keller.

Prerequisite, required of freshmen who present two years of German for entrance and do not take French.

Elective Courses.

25. **I.** Intermediate German. — For sophomores; juniors and seniors may elect. Reading of such works as Sudermann's "Frau Sorge," "Wilhelm Tell," "Die Journalisten," etc. Grammar review.
3 class hours. Credit, 3.
Mr. Keller.

Prerequisites, German 1, 2 and 3.

26. **II.** Intermediate German. — For sophomores; juniors and seniors may elect. As stated under Course 25.
3 class hours. Credit, 3.
Mr. Keller.

Prerequisite, German 25.

27. **III.** Intermediate German. — For sophomores; juniors and seniors may elect. As stated under Course 25.
3 class hours. Credit, 3.
Mr. Keller.

Prerequisite, German 26.

28. **I.** Advanced German. — For sophomores; juniors and seniors may elect. Reading and studying of Goethe's most important literary productions.
3 class hours. Credit, 3.
Mr. Keller.

Prerequisites, German 4, 5 and 6.

29. **II.** Advanced German. — For sophomores; juniors and seniors may elect. Development of the German novel; rapid reading of great novelists.
3 class hours. Credit, 3.
Mr. Keller.

Prerequisite, German 28.

30. **III.** Advanced German. — For sophomores; juniors and seniors may elect. As stated under Course 29.
3 class hours. Credit, 3.
Mr. Keller.

Prerequisite, German 29.

50. **I.** Scientific German. — For juniors; seniors may elect. Reading in German of modern magazine articles and works of a scientific nature. Different work assigned according to needs of individual students.
3 class hours. Credit, 3.
Professor Julian.

Prerequisites, German 4, 5 and 6, or German 25, 26 and 27.

51. **II.** Scientific German. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 50.

52. **III.** Scientific German. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 51.

75. **I.** German Literature. — For seniors. Advanced language and literary study. Conducted entirely in German. Lectures on German literature and history; life, customs and travel in Germany. Collateral readings, including masterpieces of different epochs, such as "Niebelungenlied," Goethe's "Faust" and one modern typical drama.
3 class hours. Credit, 3.
Professor Julian.

Prerequisites, German 28, 29 and 30.

76. **II.** German Literature. — For seniors. As stated under Course 75.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 75.

77. **III.** German Literature. — For seniors. As stated under Course 75.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 76.

78. **I.** Conversation and Composition. — For seniors; juniors may elect. Translating connected English into German. Reproducing outside readings in German orally in class.
1 class hour. Credit, 1.
Professor Julian.

Prerequisites, German 4, 5 and 6, or German 25, 26 and 27.

79. **II.** Conversation and Composition. — For seniors; juniors may elect. As stated under Course 78.
1 class hour. Credit, 1.
Professor Julian.

Prerequisite, German 78.

80. **III.** Conversation and Composition. — For seniors; juniors may elect. As stated under Course 78.
1 class hour. Credit, 1.
Professor Julian.

Prerequisite, German 79.

DIVISION OF RURAL SOCIAL SCIENCE.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Agricultural Economics.

Professor Cance, Assistant Professor Sawtelle, Miss Foley, Mr. Smart.[1]

Instruction in agricultural economics is designed to show that the agricultural industry justified its existence chiefly as a supplier of food and raw textile materials for human consumption; that agricultural success is measured by production of values rather than by production of volume of agricultural products; that the goal of the farmer is the largest net profit over a long-time period; that agricultural production includes all processes from purchase of seed and fertilizer and preparation of seedbed until the product reaches the consumer, including collection, transportation, storage, financing, packing, handling and selling; that a knowledge of the business of agriculture and agricultural commerce is to-day more necessary than a knowledge of agricultural technique.

The work of this department is conducted by means of lectures, readings and research in both library and field. A catalogue, now containing some 12,000 cards, covering the various phases of agricultural economics, is maintained. The department is also supplied with a large collection of maps, charts and statistical reports on the prices and supply of agricultural products. A goodly number of regular reports of the Bureau of Markets and other divisions of the United States Department of Agriculture are available for the use of students. Two series of bound volumes of bulletins are kept in the department offices, with duplicate series in the college library; one series already contains 12 volumes on "Co-operation in Agriculture," and the other, 15 volumes on "Marketing of Farm Products."

Required Courses.

26. **II.** Agricultural Industry and Resources. — For sophomores. A descriptive course dealing with agriculture as an industry and its relation to physiography, movement of population, supply of labor, commercial development, transportation, public authority and consumers' demand. The principal agricultural resources of the United States are studied with reference to commer-

[1] Temporary.

cial importance, geographical distribution, present condition and means of increasing the value of the product and cheapening cost of production. Lectures, assigned readings, class topics and discussions.
4 class hours. 1 2-hour laboratory period, credit, 5.
Mr. ——

Elective Courses.

50. **I.** Elements of Agricultural Economics. — For juniors; seniors may elect. This course is designed to accompany or follow the course in elements of economics. It deals with the economic principles underlying the welfare and prosperity of the farmer and those institutions upon which his economic success depends; the economic elements in the production and distribution of agricultural wealth; means of exchange; principles of rural credit; problems of land tenure and land values; taxation of farm property; and the maintenance of the economics status of the farmer. Lectures, text, readings, topics and field work.
5 class hours. Credit, 5.
Professor Cance.

51. **III.** The Evolution of Agriculture. — For juniors; seniors may elect. A general survey of the evolution of the agricultural industry. Significant developments are traced and their causes and consequences studied. An attempt is made to give the student a knowledge of the changes which have taken place and which are taking place in the agricultural industry, the conditions which accompany these changes, and to furnish a basis by which the significance and the course of present and future developments in agriculture may be judged. Special emphasis will be placed on the development of agriculture in New England and the United States. Lectures, readings and library work.
5 class hours. Credit, 5.
Assistant Professor Sawtelle.

52. **II.** Co-operation in Agriculture. — For juniors; seniors may elect. The history, principles and business relations of agricultural co-operation. (1) A survey of the development, methods and economic results of farmers' organizations and great co-operative movements; (2) the business organization of agriculture abroad, and the present aspects and tendencies in the United States; (3) the principles underlying successful co-operative endeavor among farmers, practical working plans for co-operative associations, with particular reference to purchase of supplies and the marketing of perishable products. Lectures, text, assigned readings and practical exercises.
5 class hours. Credit, 5.
Professor Cance.

53. **III.** The Agricultural Market. — For juniors; seniors and graduate students may elect. A study of the forces and conditions which determine the prices of farm products and the mechanism, methods and problems concerned with transporting, storing and distributing them. Supply and demand, course of prices, terminal facilities, the middleman system, speculation in agricultural products, protective legislation, the retail market and direct sales are taken up. The characteristics and possibilities of the New England market are given special attention. Lectures, readings, assigned studies and field work.
5 class hours. Credit, 5.
Professor Cance.

75. **II.** Rural and Business Law. — For seniors; juniors may elect. Land, titles, public roads, rights incident to ownership of livestock, contracts, commercial paper and distinctions between personal and real property. Text, written exercises, lectures and class discussions.
5 class hours. Credit, 5.
Mr. Smart.

76. **II.** Transportation of Agricultural Products. — For seniors and graduate students; juniors may elect. The development of highway, waterway and railway transportation and its relation to the agricultural development of the country; the principles governing the operation and control of transportation agencies; present-day problems relating to the shipment of farm products, rates, facilities and services; methods of reducing wastes in transportation; the economics of the good roads movement and of motor transportation. Lectures, text and field work.

5 class hours. Credit, 5.

Professor Cance.

77. **I.** Problems in Agricultural Economics. — For seniors and graduate students; juniors may elect. An advanced course for those desirous of studying more intensively some of the economic problems affecting the farmer, such as: land problems, — land tenure, size of farms, causes affecting land values, private property in land, taxation of farm property; special problems, — cost of producing farm products, farm labor in New England, immigration, agricultural credit. Opportunity is given, if practicable, for field work, and students are encouraged to pursue lines of individual interest.

5 class hours. Credit, 5.

Professor Cance.

78. **III.** Agricultural Credit Facilities. — For seniors and juniors. Lectures, discussions and assigned readings on credit needs of farmers; the legitimate use of credit in the acquisition of land, and the production, storage and marketing of agricultural products; the development of national and State rural credit institutions and laws; the powers and methods of operation of credit institutions with reference to the supply of credit for agricultural purposes; the methods by which the individual may increase his credit standing and borrowing power; ways in which the present credit facilities may be increased.

3 class hours. Credit, 3.

Assistant Professor Sawtelle.

79. **I.** Agricultural Statistics. — For seniors; juniors and graduate students may elect. The nature and sources of agricultural statistics, the methods of obtaining numerical facts, of analyzing and drawing conclusions from statistical data, and the methods of presenting in a true and forceful manner the statistical facts of the agricultural industry. Opportunity is given in the laboratory for practice in the use of statistical methods and processes, and to acquire experience in dealing with practical statistical problems. The application of statistics and statistical methods in the fields of agricultural economics, extension work, education, journalism and the business matters connected with farm operation is emphasized.

2 class hours. 3 2-hour laboratory periods, credit, 5.

Assistant Professor Sawtelle.

80. **I.** Seminar. — For seniors and graduate students. Research in agricultural economics and history; problems of New England agriculture. Library work and reports. If desirable some other topic may be substituted.

1 or 2 2-hour conference periods, credit, 1 or 2.

The Department.

81. **II.** Seminar. — For seniors and graduate students. As stated in Course 80.

1 or 2 2-hour conference periods, credit, 1 or 2.

The Department.

82. **III.** Seminar. — For seniors and graduate students. As stated in Course 80.

1 or 2 2-hour conference periods, credit, 1 or 2.

The Department.

83. **I.** Salesmanship of Agricultural Products. — For seniors; juniors may elect. The course embraces a study of the principles and practices that are involved in the selling of goods and services. The application of these principles of salesmanship to the disposal of agricultural products is especially emphasized. Types of sales, motives for buying, securing interviews, types of prospects, preparation of sales talks, meeting objections and excuses, and sales demonstrations by students and the instructor are included.
2 class hours. Credit, 2.
Mr. ——

84. **III.** Advertising Agricultural Products. — For seniors; juniors may elect. A course dealing with the application of the principles of advertising to agricultural products. A study of the nature of advertising, the economics of advertising, the use of media, copy, psychology as applied to advertising, layout, the advertising campaign, advertising agency, etc., is made. The solution of practical problems to emphasize different phases of advertising is required by students.
2 class hours. Credit, 2.
Mr. ——

85. **II.** Agricultural Prices. — For seniors and graduate students. A study of the prices of agricultural products and other commodities which are of importance in the agricultural industry. Limited to five students.
2 or 3 2-hour laboratory periods, credit, 2 or 3.
Assistant Professor Sawtelle.

86. **III.** Agricultural Prices. — For seniors and graduate students as stated in Course 85. Limited to five students.
2 or 3 2-hour laboratory periods, credit, 2 or 3.
Assistant Professor Sawtelle.

87. **III.** Foreign Trade in Agricultural Products. — For seniors and graduates; juniors may elect. A general course embracing a study of the principles and practices of international trade and the foreign commerce of the United States, particularly with reference to agricultural products. The development and present status of foreign trade in agricultural products, trade relations with foreign nations, the agencies and practices of foreign trade, foreign trade salesmanship and advertising, the status of New England with reference to foreign trade are some of the topics which will be presented. The work in the course will also include a personal study of special features of foreign trade and of the trade importance of specific subjects. Textbook, class discussions and class topics.
3 class hours. Credit, 3.
Mr. ——

88. **III.** Business Accounting. — For seniors; juniors may elect. This course aims to give the student an elementary working knowledge of the principles underlying the accounting system in the gathering, analysis and interpretation of accounting data, and of the methods used in accounting and preparing the usual types of business statements. The managerial uses of accounting as a means of business control is the keynote of the course.
1 class hour. 2 2-hour laboratory periods, credit, 3.
Admission by permission of the instructor only. Mr. ——

Agricultural Education.

Professor Welles, Professor Glick, Mr. Heald.[1]

The primary aim of the department is to train students for service in some form of educational work. Students desiring state approval as teachers of agriculture or related subjects should confer with the head of the department as early as pos-

[1] State Agent for Agricultural Teacher-Training representing the State Department of Education in the administration of vocational education acts.

sible to insure a desirable range of preparation. They should also become acquainted with the State Agent for Agricultural Teacher-Training who approves candidates for positions in agricultural departments and special schools.

The department seeks to be of the greatest possible service to students who are prepared to teach and whose scholastic standing and qualifications generally seem to make them suitable candidates for positions. Students who major in other departments but expect to teach should consult this department regarding the educational courses best suited to their purposes.

The department recommends to the State Department of Education such graduates of the college as are entitled to receive the high school teachers' term certificate.

The department is thoroughly equipped for its work with classrooms, reference material, etc.

29. **II.** Problems in Education. — For sophomores in the Division of Rural Social Science. The aim of this course is to awaken young students to the fact that what they enjoy in educational opportunities has not always existed. Our American educational policy and program is the present form of the solution of many vital problems of education. These are continually facing the newer generations as industry and living conditions change. Thinking men and women tomorrow must give attention to so vital a concern in life as education and should begin early. The work covers text, references, discussions and lectures.
3 class hours. Credit, 3.
Professor Welles.

51. **I** and **II.** Principles and Methods of Teaching. — For juniors; seniors may elect. This course is intended for students who expect to teach. Others must consult the head of the department before registering. The study covers the general principles and methods of teaching and their application to particular cases. This is an adaptation of the case plan of study. Discussions of the classroom are very important. Outside reading is required on assigned and optional matter. Observation visits to schools in session are required with full reports. Each student must prepare a lesson for teaching and teach a moot class subject to the critical analysis of the class and the instructor. A good text is the basis of the course.
5 class hours. Credit, 5.
Professor Welles.

52. **I.** History and Philosophy of Education. — For seniors and graduate students; juniors may elect. A general course in the history of educational theory and practice. Special emphasis is placed upon the philosophical background of education.
5 class hours. Credit, 5.
Professor Glick.

55. **I** and **II.** General Psychology. — For juniors; seniors and graduate students may elect. This is a basic course for those anticipating further study in psychology as well as a practical and cultural course for those who can take only one course in this field. It deals with the fundamental principles of psychology; the evolution of mind in animals and man; various types and products of social organizations; abnormal psychology including hypnotism, dreams, mental disorders, etc.
5 class hours. Credit, 5.
Professor Glick.

56. **II** and **III.** Educational Psychology. — For juniors; seniors and graduate students may elect. It is a direct application of psychology to the field of education and is a basic course for both general and specific methods. The course deals with the original nature of the child, the psychology of learning, individual

ifferences, transfer of training, mental tests, etc. Intended primarily for pro-
)ective teachers, but open to others who are sufficiently interested.
class hours. Credit, 5.
Professor Glick.
rerequisite, Agricultural Education 55 or consent of the instructor.

75. **II.** Principles of Secondary Education. — For seniors; juniors may ect. This is a study of the American high school, both junior and senior. It is esigned to acquaint the student with the aims and objectives of the high school nd the factors upon which the realization of these aims depend. Some of the)ecific topics included in the study are financial support, course of study, qualications of teachers and recent tendencies and policies in secondary education.
class hours. Credit, 3.
Professor Welles.

76. **I** and **III.** Special Methods in Teaching Agriculture and Related cience. — For seniors; juniors and others qualified may elect. Owing to the)ecialized nature of this course, the head of the department must be consulted efore registration. The course aims to set out clearly the main details in teaching griculture and related science from a vocational point of view. The home project considered the basis. The work covers material and method, laws, policies, ate requirements, common practices, teachers' subject and method outlines, roject outlines, lesson plans, moot class teaching, observation, references, weekly ral and written reports, etc. The principle of job analysis is employed throughout ie course.
class hours. Credit, 5.
Professor Welles.

77. **III.** Methods in Extension Teaching. — For seniors; juniors and hers qualified may elect. The nature of this course requires that only those who e definitely interested be admitted. Candidates must consult the head of the epartment before registering. The course consists of a survey of the field of tension work and the methods by which this work is accomplished. The specific nes dealt with are those of the county agent, boys' and girls' club leader, county emonstration agent and agricultural specialist. The administration of county, ate and federal extension service is included in the discussions. Some time will required of each student in field observation of extension work. The course ill be conducted jointly by members of the Extension Service staff and the deartment of Agricultural Education.
class hours. Credit, 3.
Professor Welles and Extension Service Staff.

79. **III.** Tests and Measurements. — Limited to fifteen seniors majoring the department. A study of the development, theory and construction of the rious types of tests and measurements with special emphasis upon their use in ie schools. Practice is given in the administration and scoring of tests. Modern atistical methods are applied to the interpretation of the results.
class hours. 2 laboratory hours, credit, 3.
Professor Glick.
erequisites, Agricultural Education 55 and 56 or consent of instructor.

80. **I, II** and **III.** Supervised Teaching. — (Includes apprentice, practice d observation teaching.) Primarily for seniors; juniors and others qualified ay be admitted by arrangement. Under certain conditions a student may absent mself from college during one term of his junior or senior year for supervised aching. Such a procedure is particularly desired for those who are preparing teach agriculture and is in accordance with the state plan which specifies the prentice method of training. For detailed information, consult the head of the partment.

Opportunities for practice teaching are sought on the campus and in nearby high schools for those who cannot absent themselves for a term of apprentice teaching. A limited amount of observation practice is permissible. Besides teaching, a student is required to pursue a course of professional reading bearing upon the subject he is teaching or observing. In all cases he is required to make detailed teaching plans covering the subject-matter of the lessons and to outline the supporting projects. The amount of credit depends upon the number, character and length of teaching exercises and conferences. Scheduled by arrangement.

Credit, 1 to 5.

The Department.

81. **III.** Seminar in Methods of Teaching. — Open to seniors majoring in Agricultural Education; graduate students and others by arrangement. This is an opportunity for those definitely intending to teach to make further studies in special lines other than agriculture, which is provided for in Agricultural Education 76. These include methods in college teaching, special methods in science, etc.

1 2-hour conference period, credit, 2.

Professor Welles.

Prerequisites, Agricultural Education 51 and 56 or equivalents.

83. **III.** Seminar in Applied Psychology. — For seniors and graduate students. Intended for those who desire to study the application of psychology in special fields such as salesmanship, advertising, medicine, law, public office, extension work, education, business, etc.

1 2-hour conference period, credit, 2.

Professor Glick.

Prerequisites, Agricultural Education 55 and 56 or 85.

85. **I.** Vocational Psychology. — For seniors and graduate students. A study of psychology as applied to vocational work other than education. Emphasis is placed upon the theory and use of vocational tests, selection of men, individual aptitudes, etc.

3 class hours. Credit, 3.

Professor Glick.

Prerequisite, Agricultural Education 55 or consent of the instructor.

95. **II.** Modern Philosophy of Education. — For seniors and graduate students; juniors may elect. A general survey of modern philosophical theories and tendencies with special emphasis upon their influence in determining present educational objectives and procedures. An analysis of the theories underlying various national cultures and ideals and the significance of education in their realization. Emphasis is placed upon the significance of curriculums in realizing definite educational objectives.

3 class hours. Credit, 3.

Professor Glick.

Prerequisite, Agricultural Education 52 or consent of instructor.

Rural Sociology.

Professor ——, Professor Sims.[1]

The courses in rural sociology are designed for two purposes: first, to give students an appreciation of the general problems of country life; second, to afford a definite training for students who wish to take up some specific form of social service. In the last ten years rural sociology has been introduced as a subject into more than 50 per cent of the agricultural schools and colleges. There is a good demand for teachers, and an increasing opportunity in other directions in this subject. The courses afford the student an opportunity to pursue graduate as well as undergraduate work. The library of the college is unusually well equipped with rural sociological material.

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[1] Absent on leave.

Required Course.

27. **III.** Elements of Rural Sociology. — For sophomores. A broad survey of the field of rural sociology, including such topics as the origin of rural sociology, its methods and problems; relation of sociological to the scientific and technical aspects of agricultural problems; the development of the rural community in New England and the west, religious, educational and social ideals of rural people; characteristics and influence of the rural environment, the movement of the rural population, the effects of immigration; rural institutions, the school, the church, local government, effects of modern conditions of life on rural institutions; rural organization; problems of progress, an analysis of the needs of rural life in its further development. Lectures, readings and essays on assigned topics.
3 class hours. Credit, 3.
Professor Sims.

Elective Courses.

50. **I.** Rural Village and Town Sociology. — For juniors; seniors may elect. Village history and evolution; present status and importance of the small town; its relation to farm and city; institutional, economic, social, cultural and moral aspects; the problems of citizenship, organization and leadership presented by the small town; schemes for improvement criticized and evaluated. This course has special value for New Englanders who wish to understand their semi-urban and town communities. Lectures, discussions and topical reports.
3 class hours. Credit, 3.
Professor Sims.

51. **II.** Rural Government. — For juniors; seniors may elect. A general survey of the development of rural government in the United States, origin of the New England town, its influence upon the west, county government, the influence of the farmer in legislation, good roads movement, credit facilities, taxation, boards of agriculture, agricultural colleges and experiment stations in relation to rural welfare; national government; a general survey of political organizations and movements among farmers in the United States and foreign countries and their influence in shaping legislation; relation of the Department of Agriculture, postal system, the various national commissions and agencies to rural welfare. Lectures, readings, written exercises on assigned topics.
class hours. Credit, 3.
Professor Sims.

52. **III.** Rural Organization. — For juniors; seniors may elect. A study of the organized agencies by which rural communities carry on their various forms of associated life, particularly a study of the ways by which the domestic, economic, cultural, religious and political institutions contribute to rural betterment; principles underlying leadership, qualifications of the paid leader and the lay leader; the field of rural social service, national, State and local, preparation and opportunity for service; rural community building, a study of organized ways and means by which aid is given local communities. The method, scope and history of local, State and national associations formed about some farm product, their influence in forming class consciousness and in shaping agrarian legislation; need of federation. Lectures, readings and essays on assigned topics.
class hours. Credit, 3.
Professor Sims.

76. **I.** Field Work in Rural Sociology. — For seniors; juniors may elect. Designed to meet the needs of students who wish to do some constructive work in rural social service while still in college. The work is carried on in co-operation with the various college agencies engaged in rural service. Any project for which credit in this course is to be asked must first have the approval of the head of the department.
2 to 6 laboratory hours, credits, 1 to 3.
Professor Sims.

Prerequisites, Rural Sociology 27 and preferably 50 or 52.

77. **II.** Rural Social Research and Surveys. — For seniors; juniors may elect. A careful study is made of the scientific method as applied to social problems, the technique of investigation and research; the procedure of gathering sociological data by means of the survey; the interpretation and graphic presentation of statistical facts. This course is indispensable for those contemplating any kind of social work. Text, lectures and laboratory work.
3 class hours. Credit, 3.
Professor Sims.

79. **I.** Seminar. — Enrollment is open to seniors, students majoring in rural sociology and others especially prepared.
1 to 3 class hours. Credit, 1 to 3.
Professor Sims.

80. **II.** Seminar. — Enrollment is open to seniors, students majoring in rural sociology and others especially prepared.
1 to 3 class hours. Credit, 1 to 3.
Professor Sims.

81. **III.** Seminar. — Enrollment is open to seniors, students majoring in rural sociology and others especially prepared.
1 to 3 class hours. Credit, 1 to 3.
Professor Sims.

Rural Home Life.

Professor Skinner, Assistant Professor Knowlton, Miss Bartley.

The emphasis of the work in Home Economics is upon home making as a fundamental vocation. To this end, not only technical courses are offered, but also those which will tend to give the student a better understanding of the place which the home should take as a factor in community life, and a sympathetic attitude toward the problems of everyday life.

The work is largely prescribed in the first two years and gives the necessary basis for the development of courses in Home Economics during the junior and senior years. It is possible for graduates of this course, if they have skillfully chosen their electives in the field of agriculture or horticulture, to engage in home industries for profit and to engage in certain phases of professional work in the field of Home Economics.

The food laboratory located in Fernald Hall is fitted with individual cabinets and gas stoves. Provision is made for practice in the preparation and serving of meals with the family as a unit. The clothing laboratory located in the Abigail Adams House is provided with modern equipment. The related science is given in the laboratories of the various departments of the college.

1. **I.** Introduction to Home Economics. — For freshmen. Lectures on the history and evolution of the home; social customs and their value in family relationships; healthful and suitable care of the wardrobe; principles of nutrition as applied to the student's life; the student's budget, and the keeping of personal accounts.
2 class hours. Credit, 2.
Miss Skinner.

28. **I.** 29. **II.** Clothing and Textiles. — For sophomores. A study of the selection and purchase of suitable materials, their character and cost; appropriateness and simplicity in dress. Practical laboratory work includes designing and drafting of patterns, the use of commercial patterns, and the making and repairing of garments.
1 class hour. 3 2-hour laboratory periods, credit, 4.
Miss Bartley.

32. **II.** Applied Design. — For sophomores. The application of the principles of design to specific problems of everyday life, using various media for their execution. Offered for the year 1925–26.

3 2-hour laboratory periods, credit, 3.
Miss Bartley.

33. **III.** Foods. — For sophomores. An introduction to the study of foods; selection, preparation and service.
3 class hours. 1 3-hour laboratory period, credit, 4.
Miss Knowlton.

50. **I.** Foods. — For juniors. A study of foods in their scientific and economic aspects, with the preparation of simple breakfasts and luncheons.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Miss Knowlton.

51. **II.** Foods. — For juniors. A further study of foods on the basis of meal planning in the home, with especial emphasis on dinners and the day's meals as a whole.
2 class hours. 2 3-hour laboratory periods, credit, 5.
Miss Knowlton.

52. **III.** Dietetics. — For juniors. A study of the food requirement throughout infancy, childhood, adolescence, adult life and old age, considering the energy value of foods and the nutritive properties of foodstuffs. Typical dietaries are planned for each period, with special regard to economic and social conditions.
2 class hours. 2 3-hour laboratory periods, credit, 5.
Miss Knowlton.

56. **I.** Clothing. — For juniors. This course aims to develop initiative, independence and art in designing garments for figures of different types, with special emphasis on proportion, color and texture. Laboratory work will be concerned with more difficult problems of garment construction.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Miss Bartley.

61. **III.** House Furnishing. — For juniors. A study of the fundamental principles of furnishing a moderate-sized home from an æsthetic and an economic standpoint. Offered for the year 1925–26.
2 class hours. 1 2-hour laboratory period, credit, 3.
The Department.

76. **I.** Home Management. — For seniors. The application of the principles of scientific management to the household, and the elements of successful home making. The family income, cost of living, household accounts, the budget and its apportionment. The responsibility of the woman to her family and the community in establishing right standards of living.
4 class hours. Credit, 4.
Miss Skinner.

78. **II.** Home Nursing. — For seniors. A study of the care of the family health; simple diseases and their prevention; the care of young children and invalids; first aid to the injured.
3 class hours. Credit, 3.
Miss Skinner.

81. **I.** The Community of the Home Economics Graduate. — For seniors. This course is intended to be a practical application of Home Economics to the various social, economic, industrial and educational problems relating to the home which the Home Economics graduate may meet in any community, either as an

employed worker or as a volunteer. This may include a field trip to Boston and other centers at an estimated cost of ten dollars. Recommended only to those pursuing a major in Home Economics.
2 class hours. 1 2-hour laboratory period, credit, 3.
Miss Knowlton.

82. **II.** Health Education. — For seniors. This course is intended to show how the Home Economics graduate fits into the health program of the school, either as a teacher or as volunteer worker. Recommended only to those pursuing a major in Home Economics.
2 class hours. 1 2-hour laboratory period, credit, 3.
Miss Knowlton.

83. **III.** Field Problems under Supervision. — For seniors. This course is intended to be a more intensive application of Home Economics to special community problems and to serve as a beginning of simple research work. Recommended only to those pursuing a major in Home Economics.
2 class hours. 1 2-hour laboratory period, credit, 3.
Miss Knowlton.

84. **III.** Millinery. — For seniors. This course considers different types of hats, their appropriateness and becomingness, with practical work in designing frames, remodeling commercial frames, covering, trimming and renovating hats.
3 2-hour laboratory periods, credit, 3
Miss Bartley.

GENERAL DEPARTMENTS.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Military Science and Tactics.

Major N. Butler Briscoe, Cav. (D. O. L.), U. S. A.; Captain Dwight Hughes, Jr., Cav. (D. O. L.) U. S. A.; Captain Daniel J. Keane, Cav. (D. O. L.), U. S. A.; Technical Sergeant John J. Lee U. S. A., Retired; Technical Sergeant James A. Warren, Cav. (D. E. M. L.), U. S. A.; and a detachment of enlisted men of the United States Army.

Under act of Congress (July 2, 1862) military instruction under a regular army officer was required in this college of all able-bodied male students. Under act of Congress June 3, 1916, as amended by act of Congress Sept. 8, 1916, there was established at this college in April, 1917, an infantry unit of the Reserve Officers' Training Corps. Following the World War and an act of Congress (July 9, 1918), the Reserve Officers' Training Corps is in operation under the regulation of the War Department, administered by the president of the college and the professor of military science and tactics.

Beginning with the fall term, 1920–21, the infantry unit of the Reserve Officers' Training Corps was converted into a cavalry unit.

The primary object of the Reserve Officers' Training Corps is to provide systematic military training at civil educational institutions, for the ultimate purpose of qualifying selected students of such institutions as reserve officers in the military forces of the United States. It is intended to attain this object during the time the students are pursuing their general or professional studies, with the least practicable interference with their civil careers, by employing methods designed to fit men physically, mentally and morally for pursuits of peace as well as war.

All male candidates for a degree in a four-year course must take for two years at least three hours a week of military training.

Students in their junior and senior years, who are approved by the president and the professor of military science and tactics, may take the advanced course if they so elect. The advanced course consists of at least five hours per week and a summer camp of about six weeks during the summer vacation, between the junior and senior years. Students taking this course are paid by the Federal government at a rate to be fixed by the Secretary of War, not to exceed the value of the army ration. The rate now fixed is 30 cents per day, which amounts to about $103 per year. Students graduating in the advanced course are eligible for commissions in the Officers' Reserve Corps, *but are not required to accept such commissions if offered.*

The uniform furnished to Freshmen and Sophomore (Basic Class) is of Olive Drab Woolen cloth, and is supplied by the Federal Government without cost. The uniforms for the Junior and Senior (Advanced Class) are of Forest Green Woolen cloth fitted and especially made for the individual student. It is expected that eventually this uniform will be furnished for the Basic Class also. This uniform is also furnished without cost to the student.

The course for cavalry units of the Reserve Officers' Training Corps includes theoretical and practical instruction in all phases of cavalry work, so distributed over the four-year college course as to qualify students at the end of the freshman year as privates of cavalry; at the end of the sophomore year as non-commissioned officers of cavalry; and upon graduation as reserve officers. The instruction in this department covers cavalry drill, cavalry weapons, — *i.e.*, rifle, pistol, saber, automatic rifle and machine gun, — map reading and military sketching, minor tactics, equitation, etc. The course in equitation includes cross-country riding and instruction in polo. So far as season and weather permit, instruction is of a practical nature out of doors.

Required Courses.

1. **I.** — For freshmen. Theoretical and practical instruction in military science and tactics, and lectures on military subjects.

3 scheduled hours, credit, 2.
THE PROFESSOR OF MILITARY SCIENCE AND TACTICS, and ASSISTANTS.

2. **II.** — For freshmen. Theoretical and practical instruction in military science and tactics, and lectures on military subjects.

3 scheduled hours, credit, 2.
THE PROFESSOR OF MILITARY SCIENCE AND TACTICS, and ASSISTANTS.

3. **III.** — For freshmen. Theoretical and practical instruction in military science and tactics, and lectures on military subjects.

3 scheduled hours, credit, 2.
THE PROFESSOR OF MILITARY SCIENCE AND TACTICS, and ASSISTANTS.

25. **I.** — For sophomores. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

3 scheduled hours, credit, 2.
THE PROFESSOR OF MILITARY SCIENCE AND TACTICS, and ASSISTANTS.

26. **II.** — For sophomores. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

3 scheduled hours, credit, 2.
THE PROFESSOR OF MILITARY SCIENCE AND TACTICS, and ASSISTANTS.

27. **III.** — For sophomores. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

3 scheduled hours, credit, 2.
THE PROFESSOR OF MILITARY SCIENCE AND TACTICS, and ASSISTANTS.

Elective Courses.

50. **I.** — For juniors. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

5 scheduled hours, credit, 4.
The Professor of Military Science and Tactics, and Assistants.

51. **II.** — For juniors. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

5 scheduled hours, credit, 4.
The Professor of Military Science and Tactics, and Assistants.

52. **III.** — For juniors. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

5 scheduled hours, credit, 4.
The Professor of Military Science and Tactics, and Assistants.

75. **I.** — For seniors. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

5 scheduled hours, credit, 4
The Professor of Military Science and Tactics, and Assistants.

76. **II.** — For seniors. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

5 scheduled hours, credit, 4
The Professor of Military Science and Tactics, and Assistants.

77. **III.** — For seniors. Theoretical and practical instruction in military science and tactics, and lectures on military subjects. Equitation.

5 scheduled hours, credit, 4
The Professor of Military Science and Tactics, and Assistants.

Physical Education and Hygiene.

Professor Hicks, Assistant Professor Gore, Mrs. Hicks, Mr. Ball, Mr. Derby, Mr. Tumey.

The purpose of the courses offered by this department is to provide active exercise and to instruct every student how to care for his health and maintain his physical condition while carrying on his college course.

The equipment consists of the Alumni Athletic Field, which has room for two football fields, a quarter-mile cinder track with a 220 straightaway, and the baseball diamond; and also the old field for class football and baseball, two tennis courts, and the drill hall floor for basket ball. For several years the drill hall floor was used for class work in gymnastics, but its condition has become so bad that this has been discontinued. During the winter months a hockey rink is provided on the college pond.

[All undergraduate male students are given a physical examination upon entering.]

Men.

Required Courses.

1. **I.** Hygiene. — For freshmen. Lectures on personal hygiene.
1 class hour. Credit, 1
Professor Hicks.

2. **I.** Recreation. — For freshmen. Outdoor games.
2 laboratory hours, credit, 1
The Department.

3. **III.** Recreation. — For freshmen. Outdoor games.
2 laboratory hours, credit, 1.
The Department.

7. **I.** 8. **II.** 9. **III.** Recreation. — Military substitute for freshman men.
3 scheduled hours, credit, 2.
The Department.

25. **I.** Recreation. — For sophomores. Outdoor games.
2 laboratory hours, credit, 1.
The Department.

26. **III.** Recreation. — For sophomores. Outdoor games.
2 laboratory hours, credit, 1.
The Department.

30. **I.** 31. **II.** 32. **III.** Recreation. — Military substitute for sophomore men.
3 scheduled hours, credit, 2.
The Department.

Elective Course.

77. **III.** Training Course. — For seniors. Election by permission only. History of physical education and supervision of athletics.
2 class hours. Credit, 2.
Professor Hicks.

Women.

Required Courses.

4. **I.** Recreation. — For freshmen. Outdoor games.
3 scheduled hours, credit, 2.
Mrs. Hicks.

5. **II.** Gymnastics. — For freshmen. Dancing, Swedish games, etc.
3 scheduled hours, credit, 2.
Mrs. Hicks.

6. **III.** Recreation. — For freshmen. Outdoor games.
3 scheduled hours, credit, 2.
Mrs. Hicks.

27. **I.** Recreation. — For sophomores. Outdoor games.
5 scheduled hours, credit, 3.
Mrs. Hicks.

28. **II.** Gymnastics. — For sophomores. Dancing, Swedish games, etc.
3 scheduled hours, credit, 2.
Mrs. Hicks.

29. **III.** Recreation. — For sophomores. Outdoor games.
5 scheduled hours, credit, 3.
Mrs. Hicks.

Elective Courses.

50. **II.** Gymnastics. — For juniors. Dancing, Swedish games, etc.
3 scheduled hours, credit, 2.
Mrs. Hicks.

76. **II.** Gymnastics. — For seniors. Dancing, Swedish games, etc.
3 scheduled hours, credit, 2.
Mrs. Hicks.

THE LIBRARY.

The general college library consists of all books belonging to the college, including the library of the Experiment Station and all divisional and departmental collections of books. The main collection now occupies the entire building, which was originally intended to serve the purposes of both chapel and library. A dictionary card catalogue is intended ultimately to cover all material in the general college library, which now comprises approximately 70,000 volumes, besides much unbound or paper-bound material, pamphlets, periodicals and newspapers. The library contains also some important special collections of books, amounting to several thousand volumes, not yet catalogued. Much of the constantly increasing pamphlet and periodical material, even though it is not yet comprehended in the general catalogue, is made promptly available by means of check lists, indexes, bibliographies and other library helps. Files of important periodicals make readily accessible to readers the latest contributions to the sum of human knowledge by contemporary leaders in many fields of thought and investigation. Works dealing with the sciences related to the processes and problems of agriculture are in greatest abundance, but literature, history and sociology are also well represented in our collections of books. The reading room is well supplied with encyclopedias and other general reference books, and with current numbers of an attractive list of popular and technical magazines and periodicals.

The greater part of the library material has been recently reclassified and recatalogued in accordance with a standard system, and is thereby rendered at all times directly accessible to teachers and students as well as library workers. From time to time informal lectures on the use of the library will be given to groups of students. By seminar and laboratory methods, individual students will be taught to appreciate books as essential sources of information and culture, and will be instructed in the use of the various devices common in libraries for finding what the library contains. All members of the college community have the privilege of free access to the book stacks for reference purposes, and books not specially reserved may be loaned for extra-library use for a period of two weeks.

The library is open from 8 A.M. to 9.30 P.M. on week days, and from 9 A.M. to 1.30 P.M. on Sundays while college is in session. Shorter hours prevail during vacation.

The Graduate School.

Edward M. Lewis, A.M., Acting President of the College.

Charles E. Marshall, Ph.D., Director of the Graduate School and Professor of Microbiology.

Graduate Staff, 1925–1926.

Acting President Lewis, Director Marshall, Professors Alexander, Beaumont, Bradley, Cance, Chamberlain, Clark, Crampton, Fernald, Foord, Glick, Graham, Lindsey, Osmun, Peters, Sears, Serex, Shaw, Thayer, Torrey, Waugh, Welles; Mr. Watts, Secretary.

HISTORY AND AIMS.

This college has provided study of a graduate nature for many years. The need for such training became real when agriculture was recognized as an aggregate of the many sciences involved and the many practices employed. The obsolete notion that agriculture is only farming has been replaced by the notion that farming, as such, is only one element in agriculture. The ramifications and divisions of agriculture are many; most of these call for advanced study and training to meet the exigencies of the times. No apology is, therefore, required for an attempt to fathom the scientific, economic and social intricacies of such a fundamental phase of human effort as agriculture. The value of such an undertaking is, or should be, patent to every intelligent mind familiar with the situation.

Graduate work has been available to students since 1893. At that time it was possible to qualify for the degree of master of science; later, in 1898, for the degree of doctor of philosophy; in 1913, for the professional degrees of master of agriculture and doctor of agriculture; in 1916, for the specific professional degree of master of landscape architecture.

To make the graduate work more effective and distinctive in agriculture, the graduate school was established in 1908. It has become the operating agency for the purpose of fitting graduates of this and other institutions for teaching in colleges, high schools and other public schools; for positions as government, State and experiment station specialists in farm management, dairying, livestock husbandry, poultry science, agronomy, landscape gardening, pomology, vegetable gardening and floriculture; for positions as bacteriologists, botanists, chemists, entomologists; for economists and social workers; and for numerous other positions requiring a great amount of scientific and professional agricultural knowledge, training and experience.

ORGANIZATION.

The school is based upon the department as the unit, and the apprenticeship system as the most effective means of instruction. This gives to the student individuality in treatment and an intimacy with actual conditions of work and operations. The student is assigned to an advisory committee, composed of the instructor in charge of his major subject as chairman, and instructors in charge of his minor subjects as members, which directs his graduate studies. The chairmen of all these committees together constitute the graduate staff, which controls the policy of the graduate school.

ADMISSION.

Admission to the graduate school will be granted: —

1. To graduates of the Massachusetts Agricultural College.

2. To graduates of other institutions of good standing who have received a bachelor's degree substantially equivalent to that conferred by this college.

In case an applicant presents his diploma from an institution of good standing, but has not, as an undergraduate, taken as much of the subject he selects for his major as is required of undergraduates at the Massachusetts Agricultural College, he will be required to make up such parts of the undergraduate work in that subject as the instructor in charge may consider necessary. He shall do this without credit toward his advanced degree.

Admission to the graduate school does not necessarily admit to candidacy for an advanced degree, — students holding a bachelor's degree being in some cases permitted to take graduate work without becoming candidates for higher degrees.

Applications for membership in the graduate school should be presented to the director of the school. Full statements of the applicant's previous training, of the graduate work desired, and of the amount and kind of work already done by him as an undergraduate should be submitted, together with a statement whether the applicant desires to work for a degree.

Registration is required of all students taking graduate courses, the first registration being permitted only after the student has received an authorization card from the director.

NATURE, METHODS AND REQUIREMENTS OF GRADUATE WORK.

Graduate work differs from undergraduate work in its purposes and methods. The primary aims of the instructor are emphasized in an attempt to have the student adjust himself and place himself in his environment; develop the rule of self-direction and self-instruction; acquire the power of accurate reasoning; gain proficiency and skill in his selected field of study or practice; and obtain an appreciative and discriminative insight into experimentation and original research. Methods are not devised, therefore, for attractiveness, entertainment and superficial reviews, but for the creation of initiative and profound thought, thorough acquaintance with detail, independent advance and industrious habits. Careful readings, lectures, conferences, surveys, laboratory exercises and field work are some of the agencies utilized.

All members of the graduate school are required to attend the course of lectures designed to supplement the technical work of all graduate studies. These lectures will be given once each week, and the students will be held responsible for the work.

Candidates for the degree of doctor of philosophy are required to prosecute three subjects, one of which shall be designated as the major and the others as minors. No two of these subjects may be taken in the same department. An original thesis shall be considered a part of the major subject.

Candidates for the degree of doctor of agriculture are required to select a major and such other subjects as will develop the major in its greatest intensity and comprehensiveness. Successful experience is also requisite, together with a thesis which represents a masterly survey or intimate study through accurate application of some phase of the major subject.

Candidates for the degree of master of science are required to prosecute two subjects, one of which shall be designated as a major and the other as a minor. When desirable, and approved by the Director, the minor may be made up of subjects from more than one department. The major and minor subjects may not be selected in the same department. An original thesis is considered a part of the major subject.

Candidates for the degree of master of agriculture are allowed greater privileges in the selection of subjects, but will be required to select a major and such other supporting lines of study as will be necessary to equip the individual professionally. A thesis which will reveal the professional training of the individual will be required.

Candidates for the degree of master of landscape architecture will be expected to conform to the established courses of the department, and to the requirements of the department in the preparation of a thesis, as well as in actual experience outside the college.

Candidates for membership in the graduate school who do not desire to work for a degree may, with the approval of the director of the school, take more than one subject in the same department, or pursue work in several departments, if their preparation will permit. A statement of the subjects chosen must in each case be submitted to the director of the graduate school for approval. The chosen subjects must bear an appropriate relation to each other.

A working knowledge of French and German is essential to successful graduate work, and students not having this will find it necessary to acquire it as soon as possible after entering. Other modern languages may be substituted if considered more valuable.

The graduate staff reserves the privilege of recommending and allowing courses in other institutions as a part of residence instruction. Such supervision will be exercised and credit granted as are essential to the highest standards of efficiency.

THESES.

A thesis is required of each candidate for an advanced degree. It must be on a topic belonging to the candidate's major subject; must show that its writer possesses the ability to carry on constructive study; must be an actual contribution to knowledge; and possess real merit.

The thesis in its final form must be submitted to the director by May 15 of the year in which the student is to present himself for the advanced degree, and before he may take the required examination. Three complete copies are required. One of the copies is to be retained as an official copy by the director, one is to be deposited in the college library, and the third is to be retained by the department in which the thesis was prepared. The candidate for the doctor's degree must be prepared to defend at the oral examination the views presented in his thesis.

FINAL EXAMINATIONS.

For the degree of doctor of philosophy or doctor of agriculture, final examinations on the minors taken are given upon the completion of the subjects. In the major subject, a written examination, if successfully passed, is followed by an oral examination in the presence of the graduate staff.

For the degree of master of science, master of agriculture or master of landscape architecture, a final examination upon the minor taken is given upon the completion of each course, and in the major a final examination, which may be either written or oral, or both, is given over all the work by the department concerned.

DEGREES CONFERRED.

The degrees of doctor of philosophy and doctor of agriculture are conferred upon graduate students who have met the following requirements: —

1. The devotion of at least three years[1] to the prosecution of three subjects of study and research in residence at the college.
2. The earning of not less than one hundred credits in the chief or major subject, and of not less than twenty-five credits in each of two minor subjects.
3. The preparation of a thesis, in the major subject, constituting an actual contribution to knowledge and accompanied by drawings if necessary. For the degree of doctor of agriculture the thesis may be modified to meet professional requirements.
4. The passing of final examinations, in both the major and minor subjects, to the satisfaction of the instructors in charge.

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[1] All time statements refer to minimum time.

5. A public oral examination.
6. The payment of all fees and college expenses required.

The degrees of master of science, master of agriculture and master of landscape architecture are conferred upon graduate students who have met the following requirements: —

1. The devotion of at least one year and a half to the prosecution of study in two subjects of study and research, not less than one full college year of which must be in residence. In the case of a master of landscape architecture the student must follow the prescribed course of study.
2. The earning of not less than fifty credits in the chief or major subject, and of not less than twenty-five credits in the minor subject. Students pursuing the course in landscape architecture will devote all of their time to the established course, and meet the conditions of one year of experience outside the college.
3. The preparation of a thesis in the major subject, constituting an actual contribution to knowledge, and accompanied by drawings if necessary.
4. The passing of final examinations, in both major and minor subjects, to the satisfaction of the professors in charge.
5. The payment of all fees and college expenses required.

The fee for the degree of master of science, master of agriculture, or master of landscape architecture is $10, and for the degree of doctor of philosophy or doctor of agriculture, $25.

COURSES OFFERED.

Courses available as major subjects for the degree of doctor of philosophy: —

Agricultural Economics.
Agronomy.
Botany.
Chemistry.
Entomology.
Horticulture.
Microbiology.
Pomology.
Rural Sociology.

Courses available as major subjects for the degree of master of science: —

Agricultural Economics.
Agricultural Education.
Agriculture.
Agronomy.
Animal Husbandry.
Botany.
Chemistry.
Entomology.
Horticulture.
Mathematics and Physics.
Microbiology.
Pomology.
Poultry Science.
Rural Sociology.
Veterinary Science.

Courses available as major subjects for the degree of master of agriculture: —

Agronomy. Animal Husbandry. Poultry Science.

The course in Landscape Architecture leads to the degree of master of landscape architecture.

Courses available as minor subjects: —

Agricultural Economics.
Agricultural Education.
Agriculture.
Agronomy.
Animal Husbandry.
Animal Pathology.
Botany.
Chemistry.
Entomology.
Horticulture.
Landscape Architecture.
Mathematics and Physics.
Microbiology.
Pomology.
Poultry Science.
Rural Sociology.
Zoölogy.

GENERAL OUTLINE OF COURSES FOR ADVANCED DEGREES.

Agricultural Economics.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — Candidates must have had the following courses or their equivalent: Economics and Sociology 50, Agricultural Economics 26 and 50.

Required Work. — Candidates must take the following courses: Agricultural Economics 51, 52, 53 and 79. These courses, specially arranged for graduates, may be taken as Courses 120, 170, 155 and 180 for graduate credit. In addition, candidates must take Courses 110, 111, 130, 165 and 175 in Agricultural Economics; Rural Sociology 27 and 50, or equivalent courses; and Economics and Sociology 51 and 52, or equivalent courses.

Each candidate will be required to have a working knowledge of the general field of economics, the history of agricultural economics, the theory of agricultural economics, the problems of agricultural production, land tenure, land problems, agricultural commerce, agricultural co-operation, agricultural credit, statistics of agriculture, and prices, markets and marketing.

For the Degree of Master of Science.

Prerequisite Work. — The same as for the degree of doctor of philosophy.

Required Work. — The same as for the degree of doctor of philosophy, except that there is no language requirement.

Graduate Courses Offered.

110. Theory of Agricultural Economics. — Readings in French, German and English on economics of agriculture. Alternate years, odd, 200 hours.
Credits, 3.
Professor Cance.

111. Current Economic Problems and Literature. — Department seminar throughout the year. Credit, 1 each term.

120. Historical and Comparative Agriculture. — General survey. May be taken in connection with Course 51. Spring term, yearly. Credits, 3.
Assistant Professor Sawtelle.

121–122. History of American Agriculture. — Special studies in the history of agricultural institutions, practices or relations. Fall term, even years.
Credits, 5.
Assistant Professor Jefferson.

130. Problems of Agricultural Production. — The relation of the farmer to the food supply. May be taken in connection with Course 77. Fall term, yearly.
Credits, 5.
Professor Cance.

140. Land Tenure and the Acquisition of Farm Land. — Readings, discussion, original exercises. Alternate years, even. Credits, 3–5.
Professor Cance.

145. Farm Labor. — Reading and investigation. Credits, 3.
Professor Cance.

150. Agricultural Commerce, Industry and Trade. — A study of trade movements and commercial activities relating to agricultural products. Fall term, alternate years, odd. Credits, 3–5.
Assistant Professor Jefferson.

155. The Agricultural Market. — A study of the forces, methods and institutions of the market for agricultural products. Spring term, yearly.
Credits, 5.
Professor Cance.

156. Specific Problems in Marketing Farm Products. — Reports and discussions. Alternate years, odd.
Credits, 3.
Professor Cance.

160. Agricultural Prices. — Winter term, yearly.
Credits, 3.
Assistant Professor Sawtelle.

161. Agricultural Prices. — Spring term, yearly.
Credits, 3.
Assistant Professor Sawtelle.

165. Transportation of Agricultural Products. — Elementary discussion and report. Winter term, yearly.
Credits, 5.
Professor Cance.

166. Specific Transportation Problems. — Original study, reading and report on certain transportation problems related to agriculture. Alternate years, odd.
Credits, 3–5.
Assistant Professor Sawtelle.

170. Co-operation in Agriculture. — Elementary problems and discussion. May be taken in connection with Course 50. Winter term, yearly. Credits, 5.
Professor Cance.

171–172. Special Problems in Co-operation for Economic Purposes. — Study, original investigation and discussion. Every third year, beginning 1922.
Credits, 3–5.
Professor Cance.

175. Agricultural Credit. — Readings and reports in addition to class lectures on agricultural credit. Taken in connection with Course 78. Spring term, yearly.
Credits, 3–5.
Assistant Professor Sawtelle.

180. Elementary Principles of Statistics. — Chiefly related to agriculture. Lectures, laboratory studies and original work. Taken in connection with Course 79. Fall term, yearly.
Credits, 5.
Assistant Professor Sawtelle.

181. Specific Problems in Statistics of Agriculture. — Alternate years, even.
Credits, 3–5.
Assistant Professor Sawtelle.

185. Rural Law. — Corresponds to Course 78. Spring term, yearly.
Credits, 5.
Mr. Smart.

186. Studies in Agricultural Legislation.
Credits, 3–5.
The Department.

190–195. Investigation of Various Problems related to Agricultural Economics. — Credit given on basis of time spent and reports submitted.

200. Thesis. — Research work in agricultural economics will be developed by four principal methods, namely, historical, statistical, accounting and general field investigation. In all instances mastery of research methods includes facility in investigation, tabulation and interpretation of results.

Agricultural Education.

MAJOR REQUIREMENTS.

For the Degree of Master of Science.

PREREQUISITE WORK. — A minimum of 25 undergraduate credits distributed mong the following lines of study: philosophy, psychology, history of education, rinciples and methods of teaching, school organization and administration. uccessful teaching experience will receive consideration.

REQUIRED WORK. — At least 50 credits must be earned from the following list f courses in the department or met by accepted transferred credits.

GRADUATE COURSES OFFERED.

00. HISTORY OF EDUCATION.	Credits, 1–10.
04. VOCATIONAL EDUCATION.	Credits, 1–10.
05. CURRICULUM STUDY.	Credits, 1–20.
10. RURAL EDUCATION.	Credits, 1–15.
15. VOCATIONAL TEACHER TRAINING.	Credits, 1–10.
20. THEORY AND USE OF MENTAL TESTS.	Credits, 1–20.
25. SECONDARY EDUCATION.	Credits, 1–15.
30. ADVANCED EDUCATIONAL PSYCHOLOGY.	Credits, 1–20.
35. EDUCATIONAL PHILOSOPHY.	Credits, 1–20.
40. GENERAL EDUCATIONAL RESEARCH.	Credits, 1–20.
45. TEACHING METHOD AND PRACTICE.	Credits, 1–10.
)0. THESIS.	Credits, 15–35.

MINOR REQUIREMENTS.

Minor work is offered in the department for the degrees of doctor of philosophy ıd master of science. Candidates must have had the equivalent of 15 under-'aduate credits in education.

Agronomy.

MAJOR REQUIREMENTS.

For the Degree of Doctor of Philosophy.

PREREQUISITE WORK. — Candidates must have had undergraduate courses 25 ıd 27 as described in this catalogue, and should have had thorough training in e elements of the natural sciences.

REQUIRED WORK. — Studies will be assigned from the courses listed below. 'ıesis problems may be chosen in the subject matter of soils, fertilizers or field ops.

For the Degree of Master of Science.

PREREQUISITE WORK. — As above.

REQUIRED WORK. — Assigned work will be selected from the courses listed low.

For the Degree of Master of Agriculture.

PREREQUISITE WORK. — The same as for the degree of master of science in so f as it is essential to establish the professional approach to agronomy, but in adition the candidate must be familiar with agronomical practices.

REQUIRED WORK. — As above.

GRADUATE COURSES OFFERED.

110. STUDIES IN THE CULTURE OF FIELD CROPS. Credits, 5–2
115. THE FERTILIZATION OF FIELD CROPS. Credits, 5–2
120. STUDIES IN HARVESTING AND STORAGE. Credits, 5–2
125. THE IMPROVEMENT OF FIELD CROPS. Credits, 5–2
130. TECHNOLOGY OF FIELD CROPS. Credits, 5–2
140. SOIL CLASSIFICATION. Credits, 5–2
145. STUDIES IN SOIL PHYSICS. Credits, 5–2
150. MOISTURE RELATIONSHIPS IN SOILS. Credits, 5–2
155. STUDIES IN SOIL MANAGEMENT. Credits, 5–2
160. SOIL TECHNOLOGY. Credits, 5–2
170. STUDIES IN SOIL FERTILITY. Credits, 5–2
180. FERTILIZER TECHNOLOGY. Credits, 5–2
190. STUDIES IN LITERATURE. Credits, 5–2
200. THESIS. Credits, 15–5

MINOR REQUIREMENTS.

Prerequisites are as stated for major work. In addition studies suited to t needs of the candidate will be selected from the above courses.

Animal Husbandry.

MAJOR REQUIREMENTS.

For the Degree of Master of Science or Master of Agriculture.

PREREQUISITE WORK. — Candidate must have had the following courses, their equivalents, before he can enter graduate work in this department: Anim Husbandry 25, 26, 50, 51, 52, 53, 75 and 78. He should also be able to show ev dence of experience in practical animal husbandry.

REQUIRED WORK. — At least 50 credits must be earned from the following li of courses offered by the department.

GRADUATE COURSES OFFERED.

100. ADVANCED BREED HISTORY. Credits, 1
110. NUTRITION OF FARM ANIMALS. Credits, 1
120. REPRODUCTION OF FARM ANIMALS. Credits, 1
200. THESIS. Credits, 2

MINOR REQUIREMENTS.

Minor work in animal husbandry may include undergraduate Courses 50, 5 53, 81 or 82, and such other work in reading and compilation of material as t instructor may outline. Written examinations will be conducted at the compl tion of each term's work.

Animal Pathology.

MINOR REQUIREMENTS.

Minor work in animal pathology for the degrees of doctor of philosophy a master of science consists of an especially planned course for graduate studen This is not an undergraduate course, but is arranged to meet the needs of gradua students who have not pursued a course in general pathology. It will continue throughout the year and include reviews in gross and microscopic anatomy, physiological, bacteriological, serological, biochemical and morbid anatomical phases of pathology. Written examinations will be given at the end of each term.

100. General Pathology. — As described above, fall term. Credits, 5.

120. General Pathology. — Continuation of 100, winter term. Credits, 5.

140. General Pathology. — Continuation of 120, spring term. Credits, 5.

160. Biochemical Phases of Pathology. — Second year, fall term. Credits, 5.

180. Pathological Histology. — Second year, winter term. Credits, 5.

Professor Gage.

Botany.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — The equivalent of certain undergraduate courses, determined by the department in the case of each student, is prerequisite.

Required Work. — Candidates will be required to take Courses 100 through 107 and 180, 190 and 200. Courses 150 through 155 may be taken for graduate credit in certain cases. The maximum number of major credits which may be earned in this way is thirty-two.

For the Degree of Master of Science.

Prerequisite Work. — The requirements are the same as for the degree of doctor of philosophy.

Required Work. — Candidates will take Courses 100 and 101 and all courses from 102 through 107 which are given during their term of residence, also 180, 190 and 200. In certain cases Courses 150 through 155 may be taken, but not more than 20 credits may be earned in this way.

Graduate Courses Offered.

Courses 100 through 106 are lecture courses. They are given in rotation, except Courses 100 and 101, which come every year.

100. Plant Physiology. — The lectures will consider, under the nutrition of the plant: its chemical structure, absorption of various nutrient substances and their changes in the plant, assimilation and dissimilation of carbon and nitrogen by autotrophic and heterotrophic plants; under changes in the form of plants: growth and form under constant external factors, the influence of variable external and inner factors on growth, form and development; and under plant movements: the various tropisms, nutations, etc. Supplemental demonstrations, laboratory work and readings in the standard texts and journals. One lecture a week for 36 weeks. Credits, 3.

101. Plant Pathology. — A general consideration of the history, nature and causes of plant disease; parasitism, predisposition, immunity, degeneration, natural and artificial infection, dissemination, epidemics, biologic strains, monstrosities and malformations, proliferation, prevention and control, economics of plant diseases. One lecture a week for 36 weeks. Credits, 3.

102. Plant Inheritance. — This course is planned to give the student a comprehensive understanding of the principles and facts of plant inheritance. A study is made of plant variations, Mendel's law of heredity, the physical basis of heredity as established by chromosome behavior, pure lines, mutations, species and graft hybrids, etc. One lecture a week for 12 weeks. Credit, 1.

103. Biologic Relations. — Consideration of certain phases of the morphological and physiological adaptations of plants with regard to insect visit; the rôle of thorns, hairs, tendrils, glands, etc. Various experiments are made to test out experimentally some of the existing theories concerning biologic adaptations. One lecture a week for 12 weeks. Credit, 1.

104. The Ecology of Plants. — This course deals with the water, light and temperature relations of plants, and the various adaptations in response to these factors; the various types of plant formation; the migration of plants; the competition of plants; invasion and successions of plants under varied conditions; and the various types of alternations and zonations. One lecture a week for 12 weeks. Credit, 1.

105. Physiological Plant Pathology. — This course considers those plant diseases not due to bacterial or fungous parasites, but resulting from unfavorable physical or chemical conditions of the soil; from harmful atmospheric influences, such as too dry air, too much moisture, hail, wind, lightning, frost; from injurious gases and liquids; from lack of or too much light; from wounds. A knowledge of the normal physiology of the plant is required. Demonstrations and laboratory work will be given, together with assigned readings. One lecture a week for 12 weeks. Credit, 1.

106. History of Botany. — An historical survey of the science; lives of noted botanists; history of certain culture plants, such as wheat, corn, coffee, potato, rice, and their influence on civilization; reading. One lecture a week for 24 weeks. Credits, 2.

107. Methods in Drawing and Photographing for Thesis and Publication. — Twelve weeks. Credits, 1–3.

108. The Comparative Anatomy of Green Plants. — See undergraduate Courses 61–63.

150. Systematic Mycology. — See undergraduate Courses 52–54.

151. Systematic Botany of the Higher Plants. — See undergraduate Courses 58 and 59.

152. Plant Histology. — See undergraduate Courses 55 and 56.

153. Cytology and Embryology. — See undergraduate Courses 82 and 83.

154. Plant Pathology. — See undergraduate Courses 75–77.

155. Plant Physiology. — See undergraduate Courses 78–80.

180. Seminar. — A weekly seminar for members of the department staff, graduate students and major senior students is held, at which important botanical papers are discussed. Attendance and participation are required. Credits, 3.

190. Collateral Reading. — Extensive reading of botanical literature in English, German and French, designed to give the student a broad knowledge of the science, is required of all major students. Final examinations are based in part upon this reading course. Credits, 5–10.

200. Thesis. — Each major student is required to select a problem in plant pathology or physiology (in other branches at the discretion of the department) for original investigation, and the thesis must embody a distinct contribution to knowledge. An effort will be made to assign problems having some bearing on scientific and economic agriculture. The thesis work counts for not more than 50 per cent of the total number of major credits required for either degree.

Minor Requirements.

For a minor a student may take such of the work offered by the department as seems best suited to his major course. Courses 150 and 155 are primarily undergraduate work which may be taken for minor credit toward advanced degrees. In most cases no problem will be assigned.

Professors Osmun, Clark, Torrey, Davis and Doran.

Chemistry.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — The candidate must have taken undergraduate Courses 1 to 87, or their equivalent.

Required Work. — The candidate will be required to take all the graduate courses listed below. He may also be required to spend at least two terms or one semester at some other recognized institution, pursuing graduate study in chemistry. For the final examinations, questions will be selected from the entire field of chemistry, with special emphasis upon the lines of work covered by the research.

For the Degree of Master of Science.

Prerequisite Work. — The same as that required for the degree of doctor of philosophy.

Required Work. — The candidate will be required to take Courses 101 and 108 through 114. In addition he will pursue the requirements of one of the following thesis subjects: —

Organic and Biochemistry. — Course 200 and either 105 or 106, and 3 credits for one term selected from Courses 103 (*b*) or (*f*), and 104.

Analytical and Industrial Agricultural Chemistry. — Courses 200, 103 (3 credits), and 3 credits for one term selected from Courses 102 and 104 through 107.

Physical Chemistry. — Courses 200, 104, and 3 credits for one term selected from Courses 102, 103 and 105 through 107.

Agricultural Chemistry. — Courses 200, 103 (3 credits), and 3 credits for one term selected from Courses 102 and 104 through 107.

The candidate must pass a final written and oral examination before the department upon undergraduate Courses 1 through 80, as well as upon all graduate work taken in chemistry.

Graduate Courses Offered.

101. Inorganic Preparations. — Laboratory. The preparation of chemical products from raw materials. The manufacture and testing of pure chemicals. The laboratory work is essentially synthetic in nature, and is designed to aid in acquiring a more adequate knowledge of inorganic chemistry than is to be obtained by chemical analysis alone. Ten to fifteen of the preparations given in Biltz's "Laboratory Methods of Inorganic Preparations" will be made by each student. Any term. Credits, 3.

Assistant Professor Serex.

102. Advanced Inorganic Preparations. — Laboratory. Continuation of Course 101. Any term. Credits, 3.

Assistant Professor Serex.

103. Advanced Analytical Chemistry. — Laboratory. This course may be taken in part as follows: (*a*) electrolytic analysis, 3 credits; (*b*) ultimate analysis, 3 credits; (*c*) special analytical work to meet the needs of the individual student, 3 credits. In addition, parts of undergraduate Courses 62, 76 and 77 may be taken, as follows: (*d*) fertilizers, 3 credits; (*e*) insecticides, 3 credits; (*f*) milk and butter, 3 credits. (*a*), (*b*), (*c*) may be taken any time; (*d*), (*e*), (*f*) must be taken at the time the undergraduate course is given.

Professor Peters.

104. Advanced Physical Chemistry. — Laboratory. Measurement of the electrical conductivity of solutions; degree of ionization; ionization constants; per cent hydrolysis of aniline hydrochloride from conductivity measurements; solubility product by the conductivity method; velocity of saponification by conductivity; neutralization point by conductivity; vapor pressure determinations; critical temperature of carbon dioxide or sulphur dioxide; transport numbers; preparation and properties of colloidal solutions; transition points by dilatometric method; heat of solution of ammonium chloride and potassium nitrate; adsorption of iodine by charcoal; determination of hydrogen ion concentration. To each student separate work will be assigned. Any term. Credits, 3.
Assistant Professor Serex.

105. Advanced Organic Chemistry. — Laboratory. The preparation of compounds not included in Courses 51 and 52, such as the Kolbe synthesis of salicylic acid; benzophenone and Beckmann's rearrangement; rosaniline, malachite green, Congo red, indigo and other dyes; synthesis of fructose; Grignard reaction. Barnett, Cain & Thorpe, Gattermann, Noyes, Fischer and other laboratory guides are used. To each student separate work will be assigned. Any term. Credits, 3.
Professor Chamberlain.

106. Advanced Physiological and Food Chemistry. — Laboratory. An intensive study of some of the more important physiological processes, physiological compounds or food ingredients. Studies of milk, blood, urine or other physiological factors under various metabolic and pathologic conditions. To each student separate work will be assigned. Any term.
Prerequisite, Chemistry 80. Credits, 3
Dr. Butler.

108. Theoretical Chemistry. — Lectures. The following topics are considered: the compressibility of the atoms; the structure of atoms; the electron conception of valence. Third term. Alternates with Course 109. Credit, 1
Professor Peters.

109. Analytical Chemistry. — Lectures. A general survey of methods and technique covering processes commonly carried out in the laboratory. Gooch's "Quantitative Analysis" is used as a text. Third term. Alternates with Course 108. Credit, 1
Professor Peters.

110. Organic Chemistry. — Lectures. Some of the following topics will be considered both theoretically and industrially: alkaloids, synthetic dyes, essential oils, terpenes, rubber, etc.; the study of methods for carrying out general reactions; isomerism, tautomerism, condensation, etc. References: Cain & Thorpe, Cohen, chemical monographs, Lassar-Cohn, Heinrichs, Molinari. First term. Credit, 1
Professor Chamberlain.

111. Advanced Physiological and Food Chemistry. — Lectures. A study of the recent advances in this field. An intimate treatment of the more important physiological factors and their relations to health, nutrition and growth. Second term.
Prerequisite, Chemistry 80. Credit, 1
Dr. Butler.

112. Theoretical and Physical Chemistry. — Lectures. The relation between the constitution and properties of compounds; mutarotation; steric hindrances; stereoisomerism of other elements than carbon; molecular association; similarity between the compounds of silicon and carbon. Third term. Alternates with Course 113. Credit, 1
Assistant Professor Serex.

113. Theoretical and Physical Chemistry. — Lectures. Radioactivity; the application of physical chemistry to industrial chemistry. Third term. Alternates with Course 112. Credit, 1.
Assistant Professor Serex.

114. Seminar. — Conferences, reports or lectures. Three terms, twice a month. Credit, $\frac{1}{2}$.
Professor Lindsey.

200. Thesis. — Research, and, in the case of a degree, the preparation of an acceptable thesis in agricultural, analytical, organic or physical chemistry, under the direction of the professor in charge of the work, provided that a candidate for the degree of doctor of philosophy shall have had the equivalent of Courses 51, 52, 65 and 86. Credit determined by work done.

Minor Requirements.

Work may be selected from any of the undergraduate Courses 27 and 51 to 80, or any of the graduate courses for which the student is prepared. In addition, the candidate may be required to pass a final written and oral examination before the department upon his entire minor work.

Entomology.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — Students must have had all the undergraduate courses given at this college or their equivalent. Opportunities to make up any deficiencies will be available while the graduate work is being carried on.

Required Work. — The graduate courses consist of lectures on all, and laboratory work on a part, of the subjects given below, together with advanced readings, seminar work and original research.

For the Degree of Master of Science.

Prerequisite Work. — The same as for the degree of doctor of philosophy.

Required Work. — A major course for the master of science degree will be about half of the courses listed below.

Graduate Courses Offered.

100. Morphology. — 1. Embryonic development of insects and polyembryony.
2. Metamorphosis and its interpretations.
3. Advanced external and internal anatomy.
4. Insect histology and physiology.
5. Ancestry and development of insects, including fossil insects.
6. Hermaphrodites in insects.
7. Hybrids.
8. Parthenogenesis, pedogenesis and heterogeny.
9. Chemistry and physics of insect colors.
10. Color patterns, their significance and value.
11. Luminosity.
12. Deformities.
13. Variation in insects.

120. Ecology. — 1. Dimorphism and polymorphism.
2. Mimicry, including concealment, protective devices and warning coloration.
3. Architecture of insect structures.
4. Relation of insects to plant fertilization and its importance.
5. Insect products of value to man.
6. Geographical distribution and methods of distribution of insects, with a consideration of life zones, barriers, etc.

7. Insect migrations.
8. Insect behavior and experimental entomology.
9. Enemies of insects.

140. Economic Entomology. — 1. Control methods.
2. Insect photography and methods of preparing illustrations.
3. Field work and life history investigations with methods for keeping records
4. Legislation about insects.
5. Studies of insecticides and their application.

160. Systematic Entomology. — 1. History of entomology and of classifications.
2. Lives and works of prominent entomologists.
3. Abundance of insects.
4. Important collections, public and private; their location and their value.
5. Types of insects; their significance, importance and location.
6. Rules of nomenclature and how they are used.
7. Methods for collecting, preparing, preserving and shipping insects.

180. Seminar. — Readings and reports on the current literature of entomology monthly meetings.

190. Collateral Readings. — The best articles on the various topics in entomology are assigned for collateral readings, and are included in the final examinations.

200. Thesis. — Original research on one or several topics in morphology, ecology economic and systematic entomology. This is expected to require from one-hal to three-quarters of the total working time of the student.

Minor Requirements.

Minor courses will cover such parts of the work outlined above as will be mos likely to prove useful in connection with the majors taken by the students, or i their future work. It is not required that such men shall have had all the undergraduate work in entomology given at this college, their credit for a minor beginning where their own undergraduate training in the subject ended.

Horticulture.

Graduate work is offered in various lines of horticulture. For the most par this is divided into the different departments which constitute the college Divisio of Horticulture, as follows: pomology, floriculture, landscape gardening, forestr and market gardening. For work in these lines application should be made direc to the heads of the several departments.

Besides this work, however, opportunity is offered for graduate study in genera horticulture, including topics from the several organized departments mentioned and also questions relating to plant breeding, general evolution, propagation manufacture of horticultural products, etc. This general work is under the direction of Professor Waugh, head of the Division of Horticulture.

Landscape Architecture.

Major Requirements.

For the Degree of Master of Landscape Architecture.

Prerequisite Work. — The undergraduate courses in the college known as Landscape Gardening 50, 51 and 52, Drawing 25, 26 and 27, Horticulture 50 and 51, and Mathematics 26 and 27 will be considered prerequisite to graduate work and any student who has not passed these courses, or their equivalent, will be required to make up such work without graduate credit.

Required Work. — Each student before he may receive the master's degree with a major in this department must convince his instructors that he has a genuine aptitude for some branch of landscape gardening, either in design, construction or management.

The minimum period of graduate study will be one and one-half years. At least one year of this time must be spent in residence at the college. One year must also be spent in practice outside the college. The work done outside the college may be prescribed by the department, and must be fully reported to the department in writing. It is essential, further, that the candidate secure the written approval of his employers outside the college. The department may, at its discretion, require a longer period of study at the college or a longer apprenticeship outside the college.

Every student before receiving his master's degree in landscape architecture must have given some thorough and fruitful study to each of the following five departments. As far as possible these studies must be of a practical nature, *i.e.*, they must be made upon actual projects in progress of development.

1. *Theory.* — The principles of esthetics as applied to landscape architecture.
2. *Design.* — The principles of pure design and their application in landscape and garden planning.
3. *Construction.* — The practical methods of carrying out landscape plans, laying out, equipment, organization of working force, time and cost keeping, etc.
4. *Maintenance.* — Methods, organization, cost.
5. *Practice.* — Office work, drafting, estimating, reporting, charges, accounting.

While great freedom is allowed to graduate students in their plans of work, a certain portion of time will always be given to systematic courses of instruction. Courses known as Landscape Gardening 175, 176, 177, 178, 179, 180, 181 and 182 are required, and may or may not be accepted for graduate credit, at the discretion of the department.

Graduate Courses Offered.

175. Theory of Landscape Art. — Same as Landscape Gardening 75. First term. Credits, 3.
Professor Waugh.

176. Civic Art. — Same as Landscape Gardening 76. Second term. Credits, 4.
Professor Waugh.

177. Country Planning. — Same as Landscape Gardening 77. Third term. Credits, 4.
Professor Waugh.

178. Architecture. — Same as Landscape Gardening 78. Third term. Given in alternate years. Credits, 3.
Assistant Professor Harrison.

179. Construction. — Same as Landscape Gardening 79. Third term. Given in alternate years. Credits, 3.
Assistant Professor Harrison.

180. Theory of Design. — Same as Landscape Gardening 80. First term. Credits, 4.
Professor Waugh.

181. Estate Design. — Same as Landscape Gardening 81. Second term. Credits, 4.
Assistant Professor Harrison.

182. Park Design. — Same as Landscape Gardening 82. Third term. Credits, 4.
Assistant Professor Harrison.

190. THEORY. — Special studies. Credits, 2–10.
The DEPARTMENT.

191. DESIGN. — Individual problems by arrangement. Credits, 2–10.
The DEPARTMENT.

192. CONSTRUCTION. — Individual problems by arrangement. Credits, 2–10.
The DEPARTMENT.

193. MAINTENANCE. — Special studies, experimental work of assigned problems.
Credits, 2–10.
The DEPARTMENT.

194. PRACTICE. — Professional field work under supervision. By arrangement.
Credits, 2–10.
The DEPARTMENT.

195. SEMINAR. Credits, 1–5.
Professor WAUGH.

200. THESIS. — Each student before receiving the master's degree with a major in landscape architecture must present a satisfactory thesis or complete project. A thesis will consist of a careful original study of some problem in landscape architecture, presented in typewritten form with any necessary illustrations, such as photographs, diagrams, drawings, etc. A project will consist of a completed set of studies of some suitable landscape-gardening problem, such as the design of a park, a real estate subdivision, an extensive playground. Such a project will usually consist of —

(*a*) Original surveys, including topography.
(*b*) Block plans, showing original design.
(*c*) A rendered plan or plans of the main features.
(*d*) Detailed working drawings.
(*e*) Estimates of cost.
(*f*) Complete report and letter of transmittal.

Credits, 5–20.

MINOR REQUIREMENTS.

Any student electing a minor in landscape architecture will be directed to take such courses from the regular catalogue list as may seem most suitable to him. Under ordinary circumstances no other work will be given to students electing minors. In special cases, however, individual problems will be assigned and individual instruction given. These exceptions will be made in cases where, by so doing, it is possible to give the student material assistance in the plan of his major work.

Microbiology.

MAJOR REQUIREMENTS.

For the Degree of Doctor of Philosophy.

PREREQUISITE WORK. — Candidate must have had Courses 50, 51, 52, 80, 81, 82 and 83, or their equivalents, before he can enter upon graduate work.

REQUIRED WORK. — Studies will be selected from the courses offered below. It will be the purpose of the department to distribute such studies among the courses offered in a manner to gain the greatest efficiency and a comprehensive knowledge of the entire field. The work will be conducted by prescribed readings, critical written reviews, conferences, lectures and laboratory exercises.

For the Degree of Master of Science.

PREREQUISITE WORK. — The same as for the degree of doctor of philosophy.

REQUIRED WORK. — Courses of a basic and applied character selected from the courses offered below which will prepare the student for effective effort.

GRADUATE COURSES OFFERED.

100. HISTORY OF MICROBIOLOGY. Credits, 5–10.

110. CYTOLOGICAL AND MORPHOLOGICAL STUDIES AND CORRESPONDING TECHNIQUE. Credits, 5–10.

120. STUDIES IN TECHNIQUE AND METHODS. Credits, 5–20.

130. PHYSIOLOGICAL STUDIES. Credits, 5–20.

135. INDUSTRIAL FERMENTATIONS. Credits, 5–10.

140. AGRICULTURAL MICROBIOLOGY — GENERAL SURVEY. Credits, 5–20.

141. MICROBIAL STUDIES IN AGRICULTURE. Credits, 5–10.

150. SOIL MICROBIOLOGY. Credits, 5–20.

160. DAIRY MICROBIOLOGY. Credits, 5–20.

170. FOOD MICROBIOLOGY. Credits, 5–20.

180. HYGIENIC MICROBIOLOGY. Credits, 5–20.

181. SPECIAL SANITARY OR HYGIENIC STUDIES. Credits, 5–10.

190. LECTURES AND STUDY OF LITERATURE. Credit, 1 each term.

200. THESIS. — Some microbiological problem related to agriculture or food. Distributed as may be most beneficial for research work. Time and credit by arrangement. Credits, 15–50.

MINOR REQUIREMENTS.

Minor work in microbiology may consist of undergraduate Courses 50, 51, 52, and other courses designed to support the major work, from among the courses offered above. The candidate will also be required to pursue graduate Course 190, or follow a course of reading and conferences through three terms. In case the candidate has had some of these courses, he will be required to take more advanced substitute courses.

Pomology.

MAJOR REQUIREMENTS.

For the Degree of Doctor of Philosophy.

PREREQUISITE WORK. — Candidates must have had the equivalent of the courses required for graduation from this college; also sufficient practical experience to enable them to understand and appreciate the problems of orchard practice.

REQUIRED WORK. — The work outlined below will be required of all candidates.

For the Degree of Master of Science.

PREREQUISITE WORK. — The same as for the degree of doctor of philosophy.

REQUIRED WORK. — One-half of the work outlined below, selected to meet the needs of the individual student, will be required.

GRADUATE COURSES OFFERED.

101. EXPERIMENTAL METHODS. Credits, 15–20.

A critical study of the methods of research that have been used or may be helpful in pomological work. The following topics will be considered from the point of view of the investigator in pomology.

1. Statistical methods.
2. Measures of growth and yield.
3. The conduct of plot experiments.

4. Methods of soil study in their relation to pomological research.
5. Chemical methods of pomological research.
6. Methods of physiology applicable to fruit plants.
7. Microchemistry.

102. Pomological Research. Credits, 15–20.
A critical survey of past and current research work in pomology. Semi-weekly meetings for reports and discussions will be held. The following topics will be taken up.

1. Orchard soil management.
2. Soil fertility and fertilizers.
3. Physiology of pruning tree fruits and bush and vine fruits.
4. Fruit bud differentiation.
5. Sterility and Fertility.
6. Genetics of fruit plants.
7. Climatology and winter injury.
8. Advanced morphology.
9. Spraying machinery and equipment.
10. Special practices.

103. Advanced Laboratory Work. Credits, 5–12.

Each student will be required to become familiar with the research work of the department and to have a share in it. So far as this has value as graduate work he will receive credit.

104. History of Pomology. Credits, 2–5.
The men, institutions and other influences that have contributed to the development of the science and art of pomology.

105. Horticultural Taxonomy. Credits, 2–3.
A study of the history and development of plant classification with special reference to horticultural plants. A study of modern classification carries with it an expression of opinion as to the evolution of cultivated plants.

106. Advanced Systematic Pomology. Credits, 6–10.
The principles of systematic pomology including a study of nut and subtropical fruits not usually dealt with in undergraduate courses.

200. Thesis. Credits, 40–50.
Each student will be required to carry out an original investigation of an assigned problem. In the planning, executing and interpreting the data of this problem he must show marked ability. The results are embodied in a thesis to be passed upon by the Department and the Graduate Staff.

Minor Requirements.

Students taking a minor in pomology will select such of the above courses as may be suited to their needs. Certain advanced undergraduate courses may also be taken for minor credit.

Poultry Science.

Major Requirements.

For the Degree of Master of Science or Master of Agriculture.

Prerequisite Work. — The postgraduate course presupposes all undergraduate work or its equivalent, together with practical experience. Without the latter, students will be unable to handle Courses 140, 150 and 160. At the discretion of the instructor in charge, graduate students may be required to pursue undergraduate courses in other departments without credit.

Required Work. — All the courses listed below. Practical poultry work may be required, but no credit will be given for such work.

GRADUATE COURSES OFFERED.

101. READING. — A review of the entire field of poultry literature, covering books, bulletins and special articles, is made, and a written report on one or more subjects required.

110. SEMINAR. — A critical review and a criticism of the more important experiments carried on at various stations in this and other countries; also a study of poultry conditions in foreign countries, methods of management, etc., besides a detailed study of some of the largest poultry projects in this country.

120. ANATOMY (GROSS AND HISTOLOGICAL), PHYSIOLOGY AND SURGERY.— This course requires a careful study of the anatomy and physiology of the fowl. Special attention is given to a study of those structures concerned with practical poultry problems. Instruction in surgical technique, adapted to fowls, may also be given.

130. BREEDING. — The student will carry on such breeding experiments as time and facilities permit. He may also do work in connection with our regular experimental projects. A detailed study of the pertinent literature will be required. Animal Husbandry 5, or its equivalent, is a prerequisite.

140. FEEDING. — A study of the relation of various foods and other substances to the morphology and physiology of the bird, with special reference to such subjects as egg production, feather form and structure, condition of flesh, bone, etc.

150. BROODING. — Studies will be made upon the relation between viability and rate of growth and the following topics: type of brooder, number of chicks in brood, ventilation, humidity, sanitation, exercise and weather conditions; also a comparison of natural methods with artificial methods of rearing chicks.

160. INCUBATION AND EMBRYOLOGY. — A number of problems of a practical, scientific and mechanical nature relating to incubation are considered. The work in embryology is of an advanced nature, dealing with its relation to morphogenesis and heredity, and presupposes an elementary knowledge of the embryology of the chick.

170. POULTRY DISEASES AND SANITATION. — In this course a study is made of various problems in poultry sanitation, with particular reference to methods relating to the control and eradication of disease.

200. THESIS.

MINOR REQUIREMENTS.

Courses 101 and 110 are designed particularly for minors.

Rural Sociology.

MAJOR REQUIREMENTS.

For the Degree of Doctor of Philosophy.

PREREQUISITE WORK. — Candidates must present satisfactory evidence of having completed at least 10 credit hours in general sociology and 10 credit hours in general economics; or take such undergraduate courses as the department may designate to satisfy this requirement.

REQUIRED WORK. — Candidates must take or pass by satisfactory examination courses offered by the department for undergraduates bearing the numbers 26, 50, 51, 52 and 75, and such courses in agricultural education and agricultural economics as may be required, not to exceed 10 credit hours in each department. Candidates will be required to select from the courses listed below as graduate courses a field for investigation and intensive study. Candidates for the doctorate must take all courses listed as graduate.

For the Degree of Master of Science.

Prerequisite Work. — The same as for the degree of doctor of philosophy.

Required Work. — Not less than 50 credit hours will be required from the courses listed below. The department will make such selection as may best meet the interest of the individual student.

Graduate Courses Offered.

177. Field Work of an Investigational Nature.

178. Rural Social Surveys.

179–181. Seminar.

182. Social Conditions of American Rural Life.

183. Social Conditions of European Rural Life.

184. Rural Institutions.

185. Rural Organization.

186. Farmers' Organizations.

187. Town and Village Rural Life.

188. Rural Health and Sanitation.

189. Rural Literature.

190. Rural Government and Law.

200. Thesis.

Veterinary Science.

Work is available in hygiene, veterinary pathology, and other special lines or divisions of the subject.

Zoölogy.

Minor Requirements.

Courses in zoölogy may be available as a minor for the degrees of doctor of philosophy and master of science. The nature of the work will necessarily vary according to circumstances, and may be intensive in a special field and correlated closely with the major work of the student, or it may be of a more general character, depending on the student's needs or previous acquaintance with general zoölogical science.

Effective in September, 1926, a tuition fee $20 per term will be charged students, residents of Massachusetts enrolled in the four-year and two-year courses.

The Short Courses.

The short courses offered by the Massachusetts Agricultural College are designed to meet the needs of those, both young and old, who cannot come to the college for the regular college courses. They furnish the student with instruction in modern accepted methods, and are planned to help the farmer and the housewife.

The short courses include:

A. The Two-Year Course in Practical Agriculture.
B. The Ten-Weeks' Winter School.
C. The Six-Weeks' Summer School.
D. The One-Year Vocational Poultry Course.

Requirements for Admission to the Short Courses. — Students must be at least seventeen years of age, and must furnish satisfactory evidence of good moral character. References are required. There are no entrance examinations. The sole test is ability to do the prescribed work. Students enrolling for the Two-Year Course in Practical Agriculture must have at least a common school education.

Expenses of Short Courses. — The expense of attending any of the short courses is approximately as follows:

Furnished rooms in private houses (per week)	$3 to $5
Board at college dining hall (per week)	$7.00
Board with private families (per week)	$6.50 to $9
Registration fee (Ten Weeks' Winter School)	$5

Tuition in all the short courses is free to residents of the Commonwealth. Small laboratory fees are charged in some of the courses.

A. Two-Year Course in Practical Agriculture.

The Two-Year Course in Practical Agriculture is offered to meet the needs of students who for one reason or another cannot take the four-year college course. It is designed to provide a large amount of practical information and training in agriculture and horticulture.

It will appeal, not only to young men and women, but also to men and women of mature years and practical experience who wish to know more about the business of farming. Although the course is planned to meet the needs of those who are not graduates of high schools, the instruction is not preparatory or elementary in its nature, but is so planned that it will be of value to all. The greater amount of academic training that some of the students may possess will in a measure be offset by the fund of practical knowledge possessed by any who have completed only the elementary schools.

The course is not intended for students enrolled in high schools. Such students should finish the high school course. Students enrolled in high schools who wish to take the course should bring a statement either from the principal of the high school or from parent or guardian asking permission to be enrolled.

The Two-Year Course in Practical Agriculture is arranged so as to provide specific vocational training for the particular lines of agricultural work which the students may select. When a student enrolls he is required to state the type of farming in which he expects to engage; and to select from the following courses of study the one he wishes to pursue: —

1. General agriculture, with animal husbandry as the principal subject.
2. General agriculture, with poultry as the principal subject.
3. Dairy manufactures.
4. General horticulture.
5. Pomology.
6. Floriculture.
7. Vegetable Gardening.

He then pursues a specially arranged course of preparation for that type of work. This specialization does not prevent his securing a general working knowledge of other subjects in which he may be interested.

The advantages of the college staff of specialists and the college plant with all its resources are thus made available to young men and young women who may not have had the opportunity of securing a high school education.

The first year consists of six months of study at the college. The term begins the first Monday in October, after the opening of the regular college session. This arrangement enables the advanced students to secure a longer period of farm training at a time when their services are especially needed in the harvesting. Classwork is concluded for freshmen with the close of the winter term, when the students are assigned farm jobs. They are available for positions on or before April 1st.

At the close of six months class work students are required to gain six months of practical experience. The college locates positions for students and so far as possible places them on farms where the experience gained will be most valuable. Students are visited by college instructors during this period, and must submit reports on their work at intervals. A total of one hundred and twenty-five credits must be earned to secure a certificate of graduation, of which twenty-five credits, or ⅕ of the total are assigned to practical training. A student failing to meet the requirements in his six months summer training cannot be enrolled for his second year, since he is not entitled to a certificate of graduation.

During the second year the student spends nine months in resident study, completing the subject pursued in the first year.

Each student is required to file with the treasurer of the college a statement, signed by the town (or city) clerk of the town (or city) from which he enrolls, stating that the parent or guardian of the student is a resident of that town.

Certificate. — Students completing satisfactorily work prescribed in the Two-Year Course will receive certificates.

Credits earned in the Two-Year Course in Practical Agriculture or in any other of the short courses except the Summer School, do not lead to the college degree.

Tuition. — Tuition is free to residents of Massachusetts. Students who are not residents of Massachusetts are charged a tuition fee of $60 a term.

B. THE WINTER SCHOOL.

The Winter School, beginning usually about January 1 and continuing for ten weeks, was started several years ago, and has always been very popular, not only with more mature farmers and their wives, but with young men and women who control or manage farms. The courses, though short, are very practical in their nature, and are so arranged that a student may choose such subjects as will enable him to specialize along the line of work in which he is most interested. There is a wide range in the choice of subjects, making it possible for the student to take work for several winters in succession. Many college graduates enroll for the Winter School.

Scholarships. — The Jewish Agricultural and Industrial Aid Society of New York has instituted a system of free scholarships to enable the children of Jewish farmers to attend the short winter course in the States in which they reside. The stipend is sufficient to pay all the expenses of the holder for the course. Such expenses usually amount to from $100 to $150. The following courses are offered: —

OUTLINE OF THE TEN WEEKS' WINTER SCHOOL, JANUARY 4 TO MARCH 13.

oil Fertility. Three lectures per week.
'ield Crops. Two lectures and one two-hour laboratory period per week.
'ypes and Breeds of Livestock. Three lectures and two two-hour laboratory periods per week.
ivestock Feeding. Three lectures per week.
nimal Breeding. One lecture and one two-hour laboratory period per week.
)airy Bacteriology. Two lectures and one two-hour laboratory period per week.
nimal Diseases and Stable Sanitation. Two lectures per week.
'oultry Husbandry. Five lectures and one two-hour laboratory period per week.
'ruit Growing. Three lectures and one two-hour laboratory period per week.
Iarket Gardening. Three lectures and two two-hour laboratory periods per week.
'loriculture. Five lectures per week.
[orticultural Manufactures. Two lectures and two laboratory periods per week.
'arm Management. Two lectures per week.
'arm Accounts. Two two-hour laboratory periods per week.
Iarketing. Two lectures per week.
otany. Two lectures per week.
ntomology. Three lectures per week.
arm Structures. Two lectures and one two-hour laboratory period per week.
'arm Machinery. Two lectures and three two-hour laboratory periods per week.
ural Sanitary Science and Hygiene. Two lectures per week.
ocational Guidance. One lecture per week.
oods. One lecture and two two-hour laboratory periods per week.
'he Business of the Household. Three class hours per week.
[ome Care of the Sick. Three class hours per week.
rinciples and Methods of Vocational Agricultural Teaching. Five exercises per week.
pecial Methods in Vocational Agricultural Teaching. Five exercises per week.
rofessional Improvement Problems. Five periods per week.

C. THE SUMMER SCHOOL.

The Summer School has been maintained by the college for a number of years. 'he experience of these years has been of value in arranging short, intensive, ractical courses that will meet the needs of teachers, home makers and professional orkers who wish instruction in agriculture, agricultural education and home :onomics, and who can most conveniently come to the college during the summer. he instruction is given by the regular members of the college staff, assisted by itside lecturers. The term period is six weeks.

College credit is now offered for work in the Summer School. For teachers and :her students interested in professional improvement, or working for degrees, iis change is especially valuable.

While agricultural courses were not presented during the past summer, if a emand develops for such work, it will be included in the program.

The nature of the work of the Summer School is indicated by the following 'pical program:

ome economics:
- Garment making, elementary
- Dress design and construction, advanced
- Millinery
- Textiles
- Health education
- Foods

ience and Allied Courses:
- Dramatic presentation
- Design and practical arts
- Hygiene and sanitation
- General science, A and B
- Public health
- Food preservation
- Flower growing
- Botany for the teacher
- Cultivated trees and shrubs

eshman and College Preparatory Courses:
- Plane geometry
- Higher algebra

Freshman and College Preparatory Courses — *Con.*
- Preparatory algebra
- Preparatory English
- College entrance English

Education and Allied Subjects:
- Principles and methods of teaching
- Special methods in vocational agricultural teaching
- Professional improvement problems
- Supervision and administration of agricultural education
- Vocational education
- Educational psychology
- Mental tests
- Content and methods in general science
- Methods of teaching English in the high school
- Method of teaching and supervision of mathematics
- Principles of secondary education
- Modern philosophy of education

D. ONE-YEAR VOCATIONAL POULTRY COURSE.

Purpose. — This course is designed for graduates of the agricultural vocation schools and others who wish to prepare themselves for practical poultry keepin and can spend only one year at college.

Scope. — The work covers seven detailed courses in poultry husbandry, a well as short-course work in fruit growing, market gardening, animal husbandr or other subjects that will be helpful to poultry raisers. In addition to classroo and laboratory exercises each student is required to put in from eight to ten hou per week at the plant in the care and management of poultry, for the purpose becoming proficient in the various branches of the work.

Entrance Requirements. — Applicants must be at least eighteen years age and have a good elementary education.

Fees. — There is no tuition for residents of Massachusetts, but a laboratory fe of $5.00 is required for both the fall and spring terms.

Note. — The course is limited to sixteen students. The One-Year Poultr Course begins at the beginning of the winter term and continues until the followin December.

Effective in September, 1926, a tuition fee of $20 per term will be charged students, residents of Massachusetts enrolled in the four-year and two-year courses.

General Information.

A. FINANCIAL AND ADMINISTRATIVE.

Student Expenses.

Tuition.[1] — Tuition is free to residents of Massachusetts. Students who are ıot residents of Massachusetts are charged a tuition fee of $180 a year. Students ntering from Massachusetts are required to file with the Secretary a statement igned by either town or city clerk stating that the applicant's father is a legal esident of Massachusetts.

All students entering the college for the first time as undergraduates or two-ear students are charged a matriculation fee of $5, which in event of a student eaving the institution shall, if all bills due the college are paid, be remitted, or vhich shall upon graduation be considered as payment for the diploma.

Dormitories and Board. — The college has dormitory accommodations for bout 62 men students. The rooms in the dormitories are occupied by the upper lassmen, hence new students find it necessary to room in private houses. The ooms in the college dormitories are unfurnished; for the most part they are rranged in suites of three, — one study room and two bedrooms. These rooms re heated by steam and lighted by electricity; they are cared for by students ccupying them. The dormitory rent for each person varies from $39 to $66 a ear. The rent for furnished rooms in private houses ranges from $1 to $4 a week or each occupant. Correspondence in regard to rooms should be addressed to he dean of the college.

Board may be obtained at the college dining hall. At present, the price of board here is $7 a week.

Expenses.

The necessary college expenses are estimated as follows: —

uition: citizens of Massachusetts, free; others, $180 per year.

	Low.	High.
latriculation fee, first year	$5 00	$5 00
oom in college dormitories or in private houses	39 00	110 00
oard, $7 per week	245 00	245 00
aundry, 50 to 85 cents a week	18 00	30 00
aboratory fees	5 00	25 00
ooks, stationery and miscellaneous items	38 00	60 00
	$350 00	$475 00

Other Expenses. — Prospective students should understand that the above stimates cover expenses which may be called strictly college expenses, and that iere are other financial obligations voluntarily placed upon students which they ıould expect to meet. Chief among these are class assessments and taxes levied r maintenance of various organizations, such as the Social Union, Athletic Asso-ation, weekly publications, etc. Such expenses vary from $15 to $30 a year. dditional financial responsibility is also assumed by students joining a fraternity entering into other social activities of the college. Students rooming in college ormitories are obliged to equip their own rooms with furniture. The college ssumes no responsibility in regard to the safe keeping of student property either

[1] This statement applies to those registering as regular or two-year students.

during the college term or vacations, except under such special arrangement a may be made with the treasurer. Besides the amount necessary for clothes an traveling, the economical student will probably spend between $400 and $50 per year.

Initial Charges.

At the opening of the college year, before students are registered in their classe the following charges are payable at the treasurer's office:

	Freshmen.	Sophomores.	Juniors an Seniors.
Matriculation fee	$5 00	–	–
Board (if at college dining hall) four weeks in advance	28 00	$28 00	$28 00
Assessment for support of Social Union	1 50	1 50	1 50
Laboratory fees	5 00	5 00	2 00–10 0
Room rent (if in college dormitory)	–	–	12 00–20 0
Student tax for support of athletics [1]	5 00	5 00	5 00
Student tax for support of nonathletic activities [1]	3 00	3 00	3 00

[1] While this is not essentially a college charge, the treasurer of the college acts as collector for the stud activity, and all students are expected to make the payment as indicated. The subscription price of t "Collegian" is fixed by the managers; the amount of athletic tax by vote of the student body.

Laboratory Fees.

The principles observed in establishing laboratory fees are the requirement th students pay for those materials actually used which cannot be supplied by t individual, and that the laboratory fees include a charge sufficient to guard agai wanton waste and breakage. Fees may be established for any course witho previous announcement. At present, the fees charged are as follows:

	Per Term.
Agronomy:	
Course 25	$2 00
Course 27	2 00
Course 50	2 50
Course 51	2 50
Course 75	2 00
Course 77	2 50
Course 78	2 50
Animal husbandry:	
Course 25	1 50
Course 26	1 50
Course 75	1 50
Dairying:	
Course 50	3 00
Course 51	3 00
Course 52	3 00
Course 75	3 00
Course 76	3 00
Course 77	3 00
Course 78	3 00
Farm management:	
Course 51	1 50
Poultry husbandry:	
Course 51	2 50
Course 52	3 00
Course 76	2 00
Course 77	2 00

	Per Te
Rural engineering:	
Course 27	$1
Course 30	1
Course 53	1
Course 55	1
Floriculture:	
Course 50	1
Course 51	1
Course 52	5
Course 53	1
Course 55	1
Course 75	2
Course 76	2
Course 77	2
Forestry:	
Course 55	1
Course 57	1
Course 58	1
Landscape gardening:	
Course 50	2
Course 51	2
Course 52	2
Course 76	3
Course 77	3
Course 80	3
Course 81	3
Course 82	3

Pomology:	Per Term.
Course 54	$4 00
Course 75	4 00

Vegetable gardening:	
Course 50	2 00
Course 52	2 00
Course 53	2 00
Course 75	3 00
Course 76	2 00

Drawing:	
Course 25	3 00
Course 26	3 00
Course 27	3 00

Botany:	
Course 3	1 50
Course 25	1 50
Course 26	1 50
Course 50	2 00
Course 51	2 00
Course 52	2 00
Course 53	2 00
Course 54	2 00
Course 55	3 00
Course 75	3 00
Course 76	3 00
Course 77	3 00
Course 78	3 00
Course 79	3 00
Course 80	3 00

Chemistry:[1]	
Course 1	3 00
Course 2	3 00
Course 4	3 00
Course 5	3 00
Course 25	4 00
Course 26	4 00
Course 30	3 00
Course 51	5 00
Course 52	5 00
Course 53	5 00
Course 61	5 00
Course 62	5 00
Course 63	5 00
Course 75	5 00
Course 80	4 00
Course 81	5 00
Course 90	5 00
Course 91	5 00
Course 92	5 00
Course 93	5 00
Course 94	5 00
Course 95	5 00
Course 96	5 00
Course 97	5 00

Entomology:	Per Term.
Course 50	$1 00
Course 51	1 00
Course 53	1 00
Course 54	1 00
Course 55	1 00
Course 75	2 00
Course 76	3 00
Course 77	1 00
Course 78	3 00

Mathematics and engineering:	
Course 27	1 50
Course 78	1 50

Microbiology:	
Course 50	5 00
Course 51	5 00
Course 52	5 00
Course 75	5 00
Course 76	5 00
Course 80	5 00
Course 81	5 00
Course 82	5 00
Course 83	5 00

Physics:	
Course 25	3 00
Course 26	3 00
Course 27	3 00
Course 50	3 00
Course 51	3 00
Course 52	3 00

Veterinary science:	
Course 78	2 00
Course 79	2 00
Course 80	2 00
Course 85	2 00
Course 86	2 00
Course 87	2 00

Zoölogy:	
Course 26	3 00
Course 50	3 00
Course 51	3 00
Course 52	3 00
Course 53	4 00
Course 75	3 00
Course 76	3 00
Course 77	3 00
Course 79	2 00

Music (each course)	3 00

Rural home life:	
Courses 28, 29	1 50
Courses 50, 51	4 00
Course 52	2 00

[1] An additional deposit of $1 for Courses 1 to 6, inclusive, and $2 for Courses 25 to 95, will be required to cover individual breakage. In case the laboratory breakage does not equal the deposit, the balance will be refunded.

Rooms.

Students are expected, as far as possible, to occupy rooms in the college dormi tories. Students who do not live in the college dormitories must secure room approved by the college. The assignment of rooms, and the general supervisio of the housing of students, is in charge of the dean. At the end of each colleg year all unoccupied rooms will be thrown open for selection, and will be assigne to students according to classes.

Living Accommodations for Women Students.

Women students attending the college live in a dormitory provided for then and take their meals at Draper Hall, which is located a short distance from th women's dormitory. The women's dormitory accommodates 98 girls, and is fu nished. The present charge for room and board for women students is $120 pe term.

Student Aid.

Self-help. — Many students are obliged to find work of some sort to earn the way through college. A few men have met their entire expenses in this manne many more have paid a large part of their expenses, and many have earned small proportion of the cost of their college education; but the college recommenc that no new student enter without having at least $200 and preferably $300 wit which to pay his way until he can establish himself in some regular work. Th college does not encourage students to enter without money in the expectation earning their way entirely. The ordinary student will find it better either to wor and accumulate money before coming to college, or to take more than four yea in completing his college course, or, instead, to borrow money sufficient to carr him through. No student should undertake work that interferes with his studie and students should understand that, owing to the large number of applicatio for employment, no one man can receive a large amount of work at the colleg A number of students find opportunities for earning money without dependir upon the college to furnish them with work.

So far as possible needy students will be employed in some department of th college. The divisions of agriculture and horticulture usually afford the mo work, although there are several permanent janitorships available for student and forty or more students are employed at the dining hall.

Application for student labor should be made directly to Ralph J. Watts, Secr tary of the college. Students whose deportment or class work is not sati factory are not likely to be continued in student labor. The most desirable an responsible positions are naturally assigned to those needy students who hav been in the institution longest and who have demonstrated their need and abilit Students, therefore, may find it rather difficult to obtain all the work they desi during their freshman year; as a matter of fact, however, any student who is cap ble of doing a variety of things, and who is a competent workman, usually finc little difficulty in obtaining all the work that he can do from the outset.

Special Notice to Needy Students. — In the last few years the demand fo paid labor on the part of new students has far exceeded the amount of emplo ment that the college can offer. The college cannot promise work to any studen particularly to freshmen; it accordingly urges prospective students who are d pendent entirely upon their own efforts not to undertake the course before the have earned enough money to carry them through, or nearly through, the fir year.

Scholarships.

The Ward Fund.

The so-called Ward Fund is available for the assistance of needy boys fro Hampshire County attending the Massachusetts Agricultural College. This fun is administered by a Board of Trustees not connected with the College. Applicatio blanks for assistance from this fund may be secured from the Treasurer of th College.

The Frederick G. Crane Fund.

The family of the late Frederick G. Crane of Dalton has presented to the Massachusetts Agricultural College a gift of $25,000 to establish a fund in memory of Frederick G. Crane, the income therefrom to be expended by the Trustees in aid of worthy undergraduate four-year students of limited financial resources attending the College, preference being given to residents of Berkshire County. Grants made from this fund are to be known as Frederick G. Crane Scholarships.

Applications.

All applications for loans or gifts from this fund should be made to the President, Massachusetts Agricultural College, Amherst, Mass., under whose direction an investigation will be made of the merits of the applicants. The purpose of this investigation will be to insure that the aid is extended to students whose parents are in such financial condition that assistance is necessary in order to insure a college education for the applicants; that it is extended only to students who propose to complete their college education at the Massachusetts Agricultural College; and that it is given to those whose character and scholarship record justifies the assistance available through this fund.

Aid to Freshmen.

Grants from the Crane Fund will be made to freshmen in the form of loans supported by notes bearing indorsements satisfactory to the President of the College. These notes will bear interest and will be negotiable. The College, however, will at its discretion cancel these notes at the end of one year if the scholarship record of the student, his character, and his plans for the future appear to the President so to warrant.

Aid to Sophomores.

Grants will be made to sophomores either on the plan outlined for freshmen as given above or on the plan outlined for juniors and seniors as given below.

Aid to Juniors and Seniors.

Grants to juniors and seniors will usually be in the form of gifts and will be awarded with consideration of the need, of the scholarship, and of the character of the applicant.

Amount of Grants.

The amount of grants from this fund, made either as loans or as gifts, will be determined by the need of the applicant and by the amount of money available in the fund. Generally one may expect to receive from $50 to $300 per year.

General Considerations.

In harmony with the provisions of the bequest, preference will be given to applicants for aid who reside in Berkshire County; but the cases of deserving students from other parts of the State will be given due consideration, and such students may under certain conditions be aided in preference to the residents of Berkshire County.

Awards will be made to girls and boys without discrimination.

Memorial Hall.

Soon after the close of the World War the alumni, students, faculty and friends of the college subscribed $150,000 for the erection of a soldier memorial building to be placed on the college campus. This building was completed in the summer of 1921. It is designed to serve as headquarters for the student activities, and as the center of the social life of the institution.

In the basement are bowling alleys, pool tables, a store, post office and barber shop. On the main floor are eight offices for leaders of various student activities, a large reading room, and a beautiful memorial room in which is found the tablet bearing the names of the sons of the college who gave their lives in the great wa On the second floor is an auditorium seating 350 persons. This room is also use for college dances.

Student Accounts.

The following rules are enforced concerning student accounts:

No student will be allowed to graduate until all bills due the institution from hi are paid.

College charges, such as room rent, laboratory fees and tuition, must be paid i advance, at the beginning of each term. This rule is strictly adhered to, and r student will be allowed to complete his registration until such payments are mad

Every student boarding at Draper Hall is required to pay at the beginning each term at least one month's board in advance; and no student will be allowe to continue to board at Draper Hall if at any time during the term he is more tha one week in arrears in his payment for board.

All money due for student labor shall at the discretion of the treasurer of tl college be applied on account toward any bills that a student may owe to the inst tution.

Honor Council.

All tests and examinations are conducted under the honor system, which is a ministered by an Honor Council chosen by the students. Recommendations f discipline are made to the President of the college by the Honor Council.

Student Relations.

The customary high standard of college men in honor, manliness, self-respe and consideration for the rights of others constitutes the standards of stude deportment.

The privileges of the college may be withdrawn from any student at any time, such action is deemed advisable.

It should be understood that the college, acting through its president or ar administrative officer designated by him, distinctly reserves the right, not on to suspend or dismiss students, but also to name conditions under which studen may remain in the institution. For example, if a student is not doing creditab work he may not only be disciplined but he may also be required to meet certa prescribed conditions in respect to his studies, even though under the foregoir rules his status as a student be not affected. The same provision applies equal to the matter of absences ("cuts"). According to the rules a student is allowed certain percentage of absences from class and other exercises. This permissio which implies a privilege and not a right, may be withdrawn at any time for an cause.

Similarly, also, it applies to participation in student activities. Though this wi ordinarily be governed by the rules as already laid down, yet, if in the judgme of the college authorities a student is neglecting his work on account of the activities, the privilege of participating in them may be withdrawn for such tin as is considered necessary. Moreover, it may be withdrawn as a punishment f misconduct. Prospective students or their parents may, upon application, obtai a copy of the faculty rules governing student relations to the college.

Infirmary.

The college maintains an infirmary for the care of sick or injured students.

The buildings now available for this purpose are quite inadequate for the nee of the institution, and it is hoped that in the near future other buildings of th kind may be erected and the general equipment somewhat amplified. At pre ent two small buildings, built especially for hospital purposes, are used for tl infirmary.

The following statement outlines the plan followed in the management of tl infirmary with respect to students: —

Management of the Infirmary.

Supervision.

1. The infirmary is under the *general supervision* of Prof. Charles E. Marshall, who is designated as Supervisor of the Infirmary. A resident nurse is in *immediate* charge of the infirmary.

Use of Infirmary.

2. Students are urged to go to the infirmary at any time that they are in need of the services rendered by the resident nurse or by a town physician. Inasmuch as the physical director gives special attention to all student diseases, it is to be expected that the majority of the students will go to the infirmary at his suggestion. This understanding, however, should in no way deter students from going to the infirmary voluntarily at any time.

General Health.

3. Students are urged to consult the physical director or the resident nurse immediately when signs of physical disorder appear. Severe attacks of cold or other forms of illness can usually be avoided if treatment is administered in the incipient stage. The purpose of the infirmary is to help maintain the general good health of the students, as well as to furnish a suitable place for professional attention in cases of severe illness or accident.

General Fee.

4. The infirmary fee will be at the rate of $2 a day, and will be charged when one or more meals are obtained at the infirmary, or when the student remains at the infirmary for one or more nights. A nominal charge will be made to outpatients for miscellaneous treatment of a minor character.

Additional Expenses.

5. In addition to the fee charged, as specified in paragraph 4, the following additional expenses will be charged to the patient: —

(*a*) *Nurses.* — In case a special nurse is required for the proper care of an individual, the services and board of this nurse will be paid by the patient. Such a nurse will be under the general supervision of the resident nurse.

(*b*) *Professional Service.* — If a student requires medical attention by a physician, he will be required to select his physician and become responsible for fees charged by the physician.

(*c*) *Supplies.* — Special medical supplies prescribed by a physician or nurse will be charged to the patient.

(*d*) *Laundry.* — Expense for personal laundry incurred by students while in the infirmary will be charged to the individual student.

B. COLLEGE ACTIVITIES.

General Exercises.

Chapel exercises are held two mornings each week. On Thursdays during the fall term, and on Wednesdays during the winter and spring terms, an afternoon assembly is held, to which some prominent layman or professional man is invited to speak. The object of these assemblies is to bring to the students discussions of topics of present-day interest. A special chapel service on Sunday is held during the winter months. Students are required to attend these general exercises, although the president is authorized to excuse from chapel any student who may object to attendance thereon because of his religious scruples, provided his request for excuse therefrom is endorsed by his parent or guardian.

Student Activities.

A large number of student organizations furnish opportunity to students for work and leadership.

The Massachusetts Agricultural College Social Union was established in 1907.

All students become members of the union by paying a small fee. In the fall and winter months the union gives a series of entertainments, free to students and faculty.

The College Senate is composed of representatives of the junior and senior classes. This body serves as a general director of undergraduate conduct, and represents before the faculty the interests of the student body.

The Young Men's Christian Association and the Young Women's Christian Association are active both socially and religiously. A Catholic club has also been organized.

Intercollegiate and intermural athletic contests are held throughout the year in the leading sports, including football, baseball, track, hockey and basketball. The athletic board, composed of alumni, faculty and students, has charge of finances, schedules, and general policies governing athletics.

The musical clubs include an orchestra and a glee club. These give a number of concerts, usually followed by dancing, during the year, both in Amherst and on tour. A dramatic club, The Roister Doisters, present annually a revue and two plays, one in connection with the promenade and the other at commencement. There are, besides the declamation and oratorical prize contests, both underclass and intercollegiate debates. The college is a member of a quadrangular league with Maine, New Hampshire, and Vermont. The college publications are the "Massachusetts Collegian," the weekly newspaper; "The Index," the year book; and "The Alumni Bulletin," issued from the office of the alumni secretary. Judging teams under the direction of the departments of Animal Husbandry, Poultry Husbandry, and Pomology compete with teams from other agricultural colleges. The Academic Activities Board, composed of alumni, faculty and students, has charge of the finances, schedules, etc., of the various clubs and publications.

C. ACADEMIC AND DEPARTMENTAL.

Degrees.

Those who complete the four-year course receive the degree of bachelor of science. The fee for graduation from the college is $5.

Graduate students who complete the assigned courses will receive the degree of master of science upon the payment of a fee of $10. Credit may sometimes be allowed towards this degree for teaching or other advanced work done in some department of the college.

Graduate students who complete the required three-year course of study, and present a satisfactory thesis, will be granted the degree of doctor of philosophy. The diploma fee in this instance is $25.

Those to whom degrees are awarded must present themselves in person at commencement to receive them. No honorary degrees are conferred.

The honorary fraternity of Phi Kappa Phi has a chapter at the agricultural college. Students are elected to membership to this fraternity on the basis of scholarship. Elections are made from the highest tenth of the senior class who have attained an average grade of at least 85 per cent during their college course.

Prizes and Awards, 1925.

Prizes and awards are offered annually in several departments for excellence in study or for other special achievements. Awards in 1925 were:

Phi Kappa Phi Elections: — Those members of the senior class whose scholarship average has been 85% or above are eligible for election to the honorary Society of Phi Kappa Phi, not more than 10% of the class, however, being elected; elections from the class of 1925 were:

George Lyle Church.	John Sebastian Lacey.
Chauncey McLean Gilbert.	Andrew Wyllie Love.
Carl Edward Frederick Guterman.	Emily Greenwood Smith.

Gordon Hugh Ward.

Grinnell Prizes. — The Grinnell prizes, given by the Hon. William Claflin of Boston in honor of George B. Grinnell, Esq., of New York, for excellence in theretical and practical agriculture. The contest is open to those senior students whose record on the registrar's books shows an average standing of 80 or above for the technical work taken in the Divisions of Agriculture and Horticulture during the junior and senior years.

First Prize, $25, Gordon Hugh Ward.

Second Prize, $15, Andrew Wyllie Love.

Third Prize, $10, Leland Little Currier.

Hills Botanical Prizes. — The Hills Botanical Prizes, given by the late Henry F. Hills of Amherst for the best and second best herbaria. Competition is open to members of the senior, junior, and sophomore classes.

First Prize, $20, Majel Margaret MacMasters, 1926.

Second Prize, $15, Philip Woodell Baker, 1927.

Burnham Prizes. — The Burnham prizes, awarded to the students delivering the best and second best declamations in the Burnham contest. The preliminary contests in declamation are open, under certain restrictions, to freshmen and sophomores.

First Prize, $15, Maxwell Henry Goldberg, 1928.

Second Prize, $10, Winthrop Ashley Ames, 1927.

Flint Prizes. — The Flint prize, awarded to the student delivering the best oration.

First Prize, $30, Gordon Hugh Ward, 1925.

Second Prize, $15, Gustave Taube, 1925.

The Massachusetts Society for the Promotion of Agriculture. — The Massachusetts Society for the Promotion of Agriculture provided for 1925–1926 two prizes of $300 each to be awarded to members of the class of 1926 for excellence in scholarship and two prizes of $200 each to members of the class of 1927 who are majoring in the Divisions of Agriculture or Horticulture. Prizes of $300: Preston Julian Davenport, 1926, and Ray Guild Smiley, 1926. Prizes of $200: Clarence Howard Parsons, 1927, and Herman Eames Pickens, 1927.

Allan Leon Pond Memorial Medal, for Excellence in Football. — The Allan Leon Pond Memorial Medal for general excellence in football in memory of Allan Leon Pond of the Class of 1920 who died February 26, 1920. In 1925 this medal was awarded to Herbert John Marx, 1925.

Southern Alumni Baseball Cup. — The Southern Alumni Baseball Cup awarded to the member of the baseball team who contributed most to the success and reputation of the team, both in respect to skill and spirit. In 1925 this medal was awarded to John Burrington Temple, 1926.

Academics Conspicuous Service Trophy. — The Academics Conspicuous Service Trophy awarded to the student who during the previous twelve months has made the most important single contribution to the academic activities. In 1925, awarded to Emil Joseph Corwin of the Class of 1925.

Roister Doister One-Act Play Prizes. — The Roister Doister One-Act Play Prizes awarded to students presenting the best one-act plays.

First Prize, $15, Dorothy Luella Leonard, 1928.

Second Prize, $10, Mary Turck Boyd, 1926.

Physical Education. — The trustees of the Frederick Cornelius Eldred Memorial Athletic Fund offer prizes of $50.00 and $30.00 to those members of the senior class who present in suitable written form, the most constructive suggestions for the physical development of the student body with particular reference to that portion which does not participate in the major sports.

The essays are not to exceed fifteen hundred words, are to be typewritten when submitted accompanied by the name of the author in a sealed envelope, and must be in the hands of the trustees of the Eldred Athletic Fund not later than April 1st, 1926. The trustees reserve the right to withdraw the offer provided no essays of sufficient merit are received.

Awards in 1925:

First prize of $50, Donald Briggs Alexander, 1925.

Honorary mention and $15, Samuel Bernhard Samuels, 1925.

(The conditions of award of these prizes may be changed by announcement by the Trustees of the Fund.)

Degrees Conferred — 1925.

Master of Science (M.Sc.).

Chase, Eleanor Frances, B.Sc., Massachusetts Agricultural College	Amesbury.
Louwsma, Henry, A.B., Hope College	Zeeland, Michigan.
Willard, John Dayton, B.A., Amherst College	Amherst.

Bachelor of Science (B.Sc.).

Alexander, Donald Briggs	Boston.
Armstrong, Bradford	Kensington, Md.
Barnes, Adrian Douglas	South Weymouth.
Bean, Francis Irving	Bradford.
Binner, Roger Stokehill	Amherst.
Bray, Ralph Hastings	Framingham.
Burhoe, Sumner Othniel	Westborough.
Cahill, Carl Winfield	Newburyport.
Casey, Alice Rita	Fall River.
Church, George Lyle	Dorchester.
Cleaves, Leighton Greenwood	Gardner.
Cooke, Robert Gordon	Atlantic.
Corwin, Emil Joseph	Winthrop.
Crosby, John Samuel	Arlington.
Currier, Leland Little	Marblehead.
Davis, Osborne Ozro	Belchertown
Duffy, Leo Francis	Springfield.
Ferranti, Edmund Tony	West Bridgewater.
Frost, Willard Chamberlain	Milford.
Gilbert, Chauncey McLean	North Amherst.
Gleason, Harold Albert	Chester.
Gordon, Samuel Francis	Ipswich.
Gordon, Solomon	Boston.
Grover, Walter Champion	Bernardston.
Guterman, Carl Edward Frederick	Springfield.
Haeussler, Gilbert Julius	Springfield.
Hanscomb, George Wilmont	North Attleborough.
Harris, Clarence Albert	Utica, N. Y.
Holbrook, Lester Morse	Fairhaven.
Holteen, John Gunnar	Quincy.
Hyde, John Worthington	Amherst.
Jack, Melvin Clifton	Amherst.
Kakavas, James Christos	Lowell.
Keith, Lewis Hayden	Bridgewater.
Kennedy, Lowell Francis	Cambridge.
Lacey, John Sebastian	Holyoke.
Landis, Rose Florence (as of the class of 1924)	Amherst.
Lavallee, Louis Palmer	Worcester.
Lord, John Frederic	Methuen.
Love, Andrew Wyllie	Auburn.
Lunt, Samuel Wilde	Cumberland Center, Me.
Marx, Herbert John	Holyoke.
McGeoch, Charles Ryerson	New Bedford.
Mouradian, Garabed Kevork	Bridgewater.
Moxon, David	Holyoke.
Nelson, Paul Redfield	Holyoke.
O'Connor, Arthur Maxwell	Amherst.
Oliver, Charles Frank, Jr.	Brockton.
Parker, Donald Llewellyn	North Adams.
Peltier, Xavier Paul	Spencer.
Poey, Frederick	Boston.
Reynolds, Joseph Sagar	Attleboro.
Roberts, Verne Edward	Amherst.
Root, Frank Edson	Bernardston.
Ross, Charles Frederick	Lee.
Ross, Donald Ernest	Amherst.
Rowell, Elwyn Joseph (as of the class of 1924)	Amherst.
Rowley, Harold Frederick	West Wareham.
Samuels, Samuel Bernhard	Holyoke.
Sazama, Robert Francis	Northampton.
Sheridan, Irwin Scott	Mansfield.
Shumway, George Francis	Monson.
Simpson, Gilbert	Holyoke.

Slack, Marion Florence	Allston.
Slowen, William Arnold	Shelburne Falls.
Smith, Emily Greenwood	Stockbridge.
Taube, Gustave	Holyoke.
Taylor, Milton Wight	Chatham.
Templeton, Robert James	Boston.
Thornton, Clarence Percy	Pelham.
Tower, Emerson	Meshanticut, R. I.
Ward, Gordon Hugh	Englewood, N. J.
Waterbury, Arthur Logan	Medford.
Whittum, Walter Willard	Springfield.
Wilcox, Stanley Dewey	Springfield.
Wilder, Frank Harris	Sterling Jct.
Woodbury, Samuel Lawrence	Springfield.
Zwisler, Frederick Fisher	Holyoke.

Bachelor of Vocational Agriculture (B.Voc.Agri.).

Cassano, Joseph	Groveland.

Registration, 1925-26.

As of November 1, 1925.

Graduate Students.

Arrington, Luther B. B.Sc., Massachusetts Agricultural College.	Amherst.
Ayers, Theodore T. B.Sc., Pennsylvania State College.	Amherst.
Bailey, John S. B.Sc., Michigan Agricultural College. M.Sc., Iowa State College.	Amherst.
Bartlett, Frederick S. B.Sc., Massachusetts Agricultural College.	Westfield.
Boylston, Ward N. A.B., University of New Hampshire.	North Amherst.
Cassidy, Morton H. B.Sc., Massachusetts Agricultural College.	Amherst.
Chesley, George L. B.H., Springfield Y. M. C. A. College.	Concord, N. H.
Cupery, Martin E. A.B., Hope College.	Friesland, Wis.
Doran, William L. B.Sc., M.Sc., Massachusetts Agricultural College.	Amherst.
Foley, Mary J. B.Sc., Massachusetts Agricultural College.	Amherst.
Garabedian, Hovanes B.A., International College, Smyrna.	Smyrna, Asia Minor.
Garvey, Mary E. M. B.Sc., Massachusetts Agricultural College.	Amherst.
Gates, A. Avery Ph.B., University of Chicago. B.D., Chicago Theological Seminary. M.Pæd., Hartford School of Pedagogy. S.T.M., Crozer Seminary.	Hampton, Conn.
Gates, Clifford O. B.S.A., Purdue University.	Kokomo, Ind.
Gilligan, Gerald M. B.Sc., Massachusetts Agricultural College.	Amherst.
Hallowell, Elizabeth A.B., A.M., Boston University.	Amherst.
Holbrook, Lester M. B.Sc., Massachusetts Agricultural College.	New Bedford.
Hyde, John W. B.Sc., Massachusetts Agricultural College.	Amherst.
Kelly, Oliver W. B.Sc., Colorado Agricultural College.	Fort Collins, Col.
Lanphear, Marshall O. B.Sc., Massachusetts Agricultural College.	Amherst.
Love, Andrew W. B.Sc., Massachusetts Agricultural College.	Auburn.
Mack, Merrill J. B.Sc., Pennsylvania State College.	Amherst.
Mayo, William I., Jr. B.Sc., Massachusetts Agricultural College.	Northampton.
McDonnell, Anna H. A.B., Smith College.	Florence.
Mortensen, Harry T. B.Sc., Michigan Agricultural College.	Amherst.
Moxon, David B.Sc., Massachusetts Agricultural College.	Holyoke.
Nielson, Knute W. B.Sc., University of Maryland.	McLean, Va.
Pendleton, Harlow L. B.Sc., Massachusetts Agricultural College.	Amherst.
Percival, Gordon P. B.Sc., Massachusetts Agricultural College.	Medfield.
Prescott, Glenn C. B.A., University of Maine.	Florence.
Raleigh, George J. B.Sc. in Agr., Kansas State Agricultural College. M.Sc., University of Nebraska.	Amherst.
Richmond, E. Avery B.Sc., Dartmouth College.	Brockton.

Ring, Gordon C. . . . . Amherst.
B.Sc., M.A., Wesleyan University.
Ross, Charles F. . . . . Lee.
B.Sc., Massachusetts Agricultural College.
Rubinwitch, Murray M. . . . . Springfield.
B.Sc., Harvard College.
Sanborn, Joseph R. . . . . North Amherst.
B.Sc., Massachusetts Agricultural College.
Sessions, Alwyn C. . . . . Logan, Utah.
B.Sc., Utah Agricultural College.
Seymour, Frank C. . . . . North Amherst.
A.B., Harvard University.
B.D., Union Theological Seminary.
Street, Orman E. . . . . Revillo, S. Dak.
B.Sc., South Dakota.
Swanback, Tore R. . . . . North Amherst.
Agronom, Agricultural College of Ultuna, Sweden.
Thies, Emily P. . . . . Amherst.
B.Sc., Michigan Agricultural College.
Thies, Wilbur H. . . . . Amherst.
B.Sc., M.Sc., Michigan Agricultural College.
Van Meter, Ralph A. . . . . Amherst.
B.Sc., Ohio State University.
Weiss, Foster H. . . . . Springdale, Conn.
B.Sc., Connecticut Agricultural College.
Willard, John D. . . . . Amherst.
B.A., Amherst College.
M.Sc., Massachusetts Agricultural College.
Wofford, Gus C. . . . . Laurens, S. C.
B.Sc., Clemson College.
Yaxis, T. George . . . . Amherst.
B.Sc., New Hampshire State University.
M.Sc., Cornell University.

Registered after the Catalogue for 1924 was published.

Binner, Roger S. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Crabtree, Margaret C. . . . . West Barrington, R. I.
A.B., Radcliffe College.
Dame, Mabelle C. . . . . Amesbury.
A.B., Radcliffe.
A.M., Columbia.
Gates, A. Avery . . . . Hampton, Conn.
Ph.B., University of Chicago.
B.D., Chicago Theological Seminary.
M. Pæd., Hartford School of Pedagogy.
S. T. M., Crozer Seminary.
Gray, Margaret F. . . . . Morgantown, W. Va.
B.Sc., Iowa State College.
Hale, Frank H. . . . . Hatfield.
A.B., St. Michael's College.
Jordan, Clifford R. . . . . Mechanic Falls, Me.
B.Sc., Bates College.
Lacroix, Donald S. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
La Montagne, Marion E. . . . . Northampton.
B.A., Smith College.
Lanphear, Marshall O. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Larkin, Clarence J. . . . . Haydenville.
B.A., Amherst College.
Nelson, Carl . . . . Gloucester.
B.Sc., Massachusetts Agricultural College.
Norwood, Howard L. . . . . Dorchester.
B.Sc., Massachusetts Agricultural College.
Patch, Henry L. . . . . Wenham.
B.Sc., Massachusetts Agricultural College.
Perry, John T. . . . . Waltham.
B.Sc., Massachusetts Agricultural College.
Proctor, Ralph W. . . . . Arlington Heights.
B.Sc., Tufts College.
Richardson, Lewis E. . . . . Rockville.
B.Sc., Massachusetts Agricultural College.
Robertson, William F. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Stickel, Paul W. . . . . Brooklyn, N. Y.
B.Sc., New York State College of Forestry.
M.F., Yale School of Forestry.
Talmage, Harry J. . . . . Hatfield.
B.Sc., Massachusetts Agricultural College.
Wilkins, Roland L. . . . . North Jay, Me.
B.Sc., University of Maine.

Class of 1926.

Baker, Francis Everett	Hopkinton	Phi Sigma Kappa.
Baker, Frederic Allen	Springfield	Phi Sigma Kappa.
Barber, Elmer Everett	Jamaica Plain	Kappa Epsilon.
Bartlett, Herbert Franklin	West Springfield	Alpha Gamma Rho.
Block, Harry William	Maplewood	13 South College.

Bosworth, Marguerite Rose	Holyoke	Abigail Adams House.
Bosworth, Maude Elinor	Holyoke	Abigail Adams House.
Bower, James, Jr.	Holyoke	Kappa Epsilon.
Boyd, Mary Turck	Ontega, Fla.	Abigail Adams House.
Bruorton, Earle Wallace	Reading	French Hall.
Budge, William Karl	Mattapan	3 North College.
Burnham, James Erastus	Springfield	Lambda Chi Alpha.
Burt, Stanley Lyman	Easthampton	Alpha Sigma Phi.
Cassidy, Marion Stewart	Wellesley	Abigail Adams House.
Cormier, Francis Joseph	Newtonville	Phi Sigma Kappa.
Couhig, Philip Henry	Beverly	Q. T. V.
Davenport, Preston Julian [1]	Shelburne Falls	Q. T. V.
Davis, Evelyn Louise	Springfield	Abigail Adams House.
Dick, Ernest Albert	Lawrence	Alpha Gamma Rho.
Dodge, Eliot Perkins	Beverly	Theta Chi.
Doolittle, Alden Hartwell	Northfield	The Aggie Inn.
Douglass, Earle Lawrence	Springfield	Alpha Gamma Rho.
Dow, Philip Norman	Bolton	Alpha Gamma Rho.
Drake, Dorothy Madeline	Cambridge	Abigail Adams House.
Durkee, Lewis Leland	Beverly	Theta Chi.
Fessenden, Richard William	Middleborough	Alpha Gamma Rho.
Fitzgerald, Lillian Alice	Holyoke	Abigail Adams House.
Flynn, Alan Foster	Newton	Kappa Epsilon.
Ford, William Warner	Dalton	Alpha Gamma Rho.
Fraser, Carl Arthur	Westborough	Theta Chi.
Fraser, Harry Edward	Jamaica Plain	Kappa Sigma.
Galbraith, Leo Lake	South Hadley	Kappa Gamma Phi.
Gavin, Linus Arthur	Natick	Kappa Sigma.
Goodwin, Marvin Warren	Reading	Alpha Sigma Phi.
Goren, Louis	Chelsea	14 South College.
Grant, Theodore James	Auburndale	13 North College.
Grayson, Herbert	Milford	Alpha Sigma Phi.
Greenwood, Elliott Kelton	Hubbardston	Q. T. V.
Gustafson, Alton Hermon	Campello	Clark Hall.
Hatch, Harold Curtis	Melrose	Alpha Gamma Rho.
Haynes, Walter Lincoln	Springfield	Phi Sigma Kappa.
Hill, Arthur Blair	Walpole	Phi Sigma Kappa.
Hollingworth, Duncalf Wright	Providence, R. I.	Lambda Chi Alpha.
Howes, Stanley Edward	Brimfield	Alpha Gamma Rho.
Huke, Barbara Allen	South Hadley Falls	Abigail Adams House.
Jameson, Matthew	Everett	Kappa Epsilon.
Jensen, Harold Stery	Westfield	Sigma Phi Epsilon.
Johnson, Philip Gordon	Amherst	West Street.
Jones, Alvah Wesley	Salisbury	Kappa Gamma Phi.
Jones, Lawrence Lakin	Campello	Phi Sigma Kappa.
Kafafian, Sarkis Petros	Amherst	11 North College.
Kelso, George	Reading	Sigma Phi Epsilon.
Lambert, John Ford	Gleasondale	Lambda Chi Alpha.
Langshaw, Hatton, Jr.	New Bedford	Alpha Sigma Phi.
Larsinos, George John	Westfield	17 North College.
Loud, Emery Shaw	North Abington	Theta Chi.
MacMasters, Majel Margaret	Ashburnham	Abigail Adams House.
Mann, Albert Irving	Dalton	Sigma Phi Epsilon.
Moberg, Herbert Elof	Brockton	Alpha Sigma Phi.
Moran, John	Amherst	51 Northampton Road.
Needham, Basil Arthur	Taunton	Sigma Phi Epsilon.
Nichols, Chester Willard	Natick	54 Lincoln Avenue.
Nichols, Helen Louise	Northampton	200 Bridge Street, Northampton.
Nickerson, Elsie Elizabeth	East Boston	Abigail Adams House.
Norcross, Roy Ellis	Brimfield	Lambda Chi Alpha.
Novick, Leo Altschuler	Amherst	56 Pleasant Street.
Otto, Raymond Herman	Lawrence	Kappa Gamma Phi.
Palmer, Cary Davis	Grafton, Vt.	3 North College.
Peirce, Veasey	Dorchester	Phi Sigma Kappa.
Pomeroy, Elizabeth Clark	Longmeadow	Abigail Adams House.
Potter, Royal Wesley	Providence, R. I.	Phi Sigma Kappa.
Putnam, Ruth Evelyn	Greenfield	Abigail Adams House.
Rainault, Ernest	Holyoke	Kappa Epsilon House.
Reed, Charles Porter	West Bridgewater	Lambda Chi Alpha.
Richards, James Marsh	Springfield	Phi Sigma Kappa.
Richardson, Henry Howe	Millis	Phi Sigma Kappa.
Robinson, Clifton Fairbanks	Newtonville	Q. T. V.
Rowen, Edward Joseph	Westfield	Sigma Phi Epsilon.
Sawyer, Roland Damon, Jr.	Ware	The Aggie Inn.
Shea, Margaret Catherine	Holyoke	Abigail Adams House.
Smiley, Ray Guild	Worcester	Alpha Sigma Phi.
Smith, Margaret Park	Taunton	Abigail Adams House.
Smith, Myron Newton	Millbury	Phi Sigma Kappa.
Smith, Raymond Ellingwood	Salem	French Hall.
Sniffen, Loren Fillow	Westport, Conn.	84 Pleasant Street.
Spooner, Raymond Hildreth	Brimfield	Clark Hall.
Stevens, Alvin Gay	Needham	Kappa Sigma.
Stopford, William Turner	Newtonville	Theta Chi.
Sullivan Donald Clifford	Amherst	25 Gray Street.
Sweetland, Augustus Francis	Stoneham	Q. T. V.
Temple, John Burrington	Shelburne Falls	Q. T. V.
Thompson, Gerald Thayer	Shelburne Falls	Theta Chi.

[1] Candidate for degree of B.Voc.Agri.

Thurlow, George Harold	West Newbury	Kappa Sigma.
Tucker, Edwin Locke	Baldwinsville	Kappa Gamma Phi.
Tulenko, John	Sunderland	Sunderland.
Turner, Charles Edgar	Springfield	8 Mt. Pleasant.
Van Alstyne, Lewis Morrell	Kinderhook, N. Y.	Phi Sigma Kappa.
Walsh, Philip Baker	Amherst	35 East Pleasant Street.
Warren, Francis Walter	Stow	Theta Chi.
Wheeler, Ellsworth Haines	Bolton	Alpha Gamma Rho.
White, Earl Martin	Abington	Kappa Sigma.
White, Montague	West Hartford, Conn.	Q. T. V.
Williams, Donald Reed	Northfield	Alpha Sigma Phi.
Wilson, James Stewart	Brooklyn, N. Y.	Phi Sigma Kappa.
Yarwood, George Arthur	Syracuse, N. Y.	101 Butterfield Terrace.

Class of 1927.

Albertini, Paul Flanders	Billerica	Kappa Epsilon.
Ames, Robert Call	Vineyard Haven	46 Pleasant Street.
Amstein, William Gerald	South Deerfield	Q. T. V.
Anderson, Andrew Bremer	Hudson	Lambda Chi Alpha.
Baker, Philip Woodell	Amherst	165 South Pleasant Street.
Barney, Laurence Hillman, Jr.	New Bedford	2 North College.
Berry, George Robert	Northampton	Alpha Sigma Phi.
Biron, Raphael Alfred	Amesbury	Theta Chi.
Black, Lewis Herbert	Williamsburg	Alpha Gamma Rho.
Boden, Frank Joseph	North Wilbraham	29 North Prospect Street.
Botulinski, Frank John	Boston	Kappa Gamma Phi.
Bovarnick, Max	Dorchester	14 South College.
Bray, Frederick Roland	Amherst	5 Hitchcock Street.
Briggs, Lawrence Elliott	Rockland	Theta Chi.
Bruce, Frances Clara	Easthampton	Abigail Adams House.
Buckler, Ella Maude	Pittsfield	Abigail Adams House.
Burrell, Robert Wallace	Abington	Theta Chi.
Campbell, Jean Matilda	West Medford	Abigail Adams House.
Carlson, Oscar Ernest	Boston	Kappa Epsilon.
Cartwright, Calton Oliver[1]	Northampton	Kappa Epsilon.
Chamberlain, Alexander Rodger	Springfield	Lambda Chi Alpha.
Clagg, Charles Floyd	Barnstable	Alpha Gamma Rho.
Cobb, Roger Madison	Wrentham	15 Hallock Street.
Connell, Edward Anthony	Malden	Sigma Phi Epsilon.
Cook, Wendell Burnham	Townsend	Alpha Gamma Rho.
Crooks, Clarence Arthur	North Brookfield	Alpha Gamma Rho.
Cummings, Maurice Andrew	Cambridge	Theta Chi.
Cutler, Samuel	Springfield	15 South College.
Davison, Ruth Eugenia	West Springfield	Abigail Adams House.
Difley, Raymond Frederick	Worcester	Phi Sigma Kappa.
Dole, William Levi	Medford	Kappa Sigma.
Elder, Hubert Gray	Amherst	39 Amity Street.
Farwell, Theodore Austin	Turners Falls	Alpha Sigma Phi.
Foley, Richard Carol	Portland, Me.	Sigma Phi Epsilon.
Galanie, Demetrius Lincoln	Natick	Alpha Sigma Phi.
Goller, Hilda Margaret	Holyoke	Abigail Adams House.
Goodell, Ruth Edna	Westborough	Abigail Adams House.
Greenaway, James Emerson	Springfield	Lambda Chi Alpha.
Griffin, Raymond George	Southwick	Sigma Phi Epsilon.
Haertl, Edwin Jacob	West Roxbury	Kappa Sigma.
Hanson, Daniel Cameron	Dracut	Alpha Gamma Rho.
Harris, Herbert Joseph	Springfield	The Apiary.
Hart, Ralph Norwood	Boston	Alpha Gamma Rho.
Haskins, Ralph Warner	Greenfield	Q. T. V.
Hatch, George Franklin, Jr.	West Roxbury	Theta Chi.
Henneberry, Thomas Vincent	Manchester	2 North College.
Hilyard, Joseph Raymond	Beverly	Q. T. V.
Huthsteiner, Elladora Kathryn	Pittsfield	Abigail Adams House.
Joyce, Milton Goff	Rumford, R. I.	44 Triangle Street.
Krassovsky, Leonid Alexander	Russia	Kappa Gamma Phi.
Kuzmeski, John William	Leverett	Amherst, R. F. D.
LeNoir, Thomas Benjamin	Greenwood	Alpha Sigma Phi.
Lyman, Orlando Hammond	Hilo, Hawaii	Phi Sigma Kappa.
Mahoney, John Joseph	Westfield	Q. T. V.
Malley, Joseph Anthony	Watertown	Kappa Gamma Phi.
Maxwell, Lewis Joseph	Stoneham	West Experiment Station.
McAllister, Robert Wright	North Billerica	Alpha Gamma Rho.
McCabe, Edith Mary	Holyoke	Abigail Adams House.
McVey, Ernest Gregory	Stoughton	Q. T. V.
Merlini, Angelo Albert	North Adams	Sigma Phi Epsilon.
Milligan, Kenneth William	State Line	Lambda Chi Alpha.
Morrill, Alfred Clayton	Natick	Phi Sigma Kappa.
Mullen, Francis Redding	Becket	Sigma Phi Epsilon.
Murdough, Edwin Lincoln	Springfield	Lambda Chi Alpha.
Nash, Norman Blake	Abington	Kappa Sigma.
Nottebaert, Harry Charles	Lexington	Lambda Chi Alpha.
Parkin, William Hildreth	Chicopee	West Experiment Station.
Parsons, Clarence Howard	North Amherst	North Amherst.
Parsons, Josiah Waite, Jr.	Northampton	Kappa Sigma.
Partenheimer, Merrill Henry	Greenfield	Phi Sigma Kappa.
Pickens, Herman Eames	Stoneham	Kappa Gamma Phi.
Powell, Charles Mason	Brookfield	Theta Chi.

[1] Candidate for degree of B.Voc.Agri.

Pratt, Martha Elizabeth	Hadley	116 Pleasant Street.
Pyle, Everett John	Plymouth	Theta Chi.
Reed, James Burbank	Waltham	Theta Chi.
Rhoades, Lawrence Duncan	New Marlborough	Alpha Gamma Rho.
Richter, Otto Hermann	Holyoke	Alpha Sigma Phi.
Rivnay, Ezekiel	Holyoke	56 Pleasant Street.
Robinson, Neil Cooley	Arlington Hts.	2 North College.
Russell, Charles Edwin	West Brookfield	Stockbridge Hall.
Savage, Donald Clifford	South Orange, N. J.	13 Phillips Street.
Sharp, Dallas Lore, Jr.	Hingham	Q. T. V.
Sherman, Willis Whitney	Boston	Stockbridge Hall.
Snyder, Allan	Holyoke	Alpha Sigma Phi.
Spelman, Albert Francis	New London, Conn.	14 North College.
Swan, Frederick Walter	Milton	Q. T. V.
Thompson, Arthur Richard	West Bridgewater	Lambda Chi Alpha.
Tobey, Edwin Albert	Belmont	Phi Sigma Kappa.
Verity, Herbert Foster	Woburn	Q. T. V.
Walker, Almeda Marion	Southbridge	Abigail Adams House.
Whitaker, Lewis Harlow	Hadley	Kappa Sigma.
White, John Everett	Abington	Kappa Sigma.
Wiggin, Jennie May	Worcester	Abigail Adams House.
Williams, Earl Fletcher	Whitinsville	Kappa Epsilon.

CLASS OF 1928.

Abrahamson, Howard Joseph	Waltham	9 South College.
Agambar, Arnold William	Holyoke	81 Pleasant Street.
Allen, Leo Linwood Fenton[1]	Athol	Theta Chi.
Amatt, Jack	Northampton	Kappa Sigma.
Barber, Ruth Moulton	Monson	Abigail Adams House.
Barnard, Ellsworth	Shelburne Falls	Q. T. V.
Bartlett, Kenneth Alden	Dorchester	Lambda Chi Alpha.
Batchelder, Lora Margaret	Easthampton	Abigail Adams House.
Baumgartner, Hans	Pittsfield	11 South College.
Bearse, Gordon Everett	Medfield	1 North College.
Beeman, Marjorie Elise	Ware	Abigail Adams House.
Biggs, Edward Mark	New York, N. Y.	Kappa Epsilon.
Blomquist, Gustave Stanley	Wollaston	Lambda Chi Alpha.
Bradford, David Carlton	Springfield	27 Fearing Street.
Bray, Walter Abner	Amherst	5 Hitchcock Street.
Brockway, Horace Taylor, Jr.	South Hadley	Q. T. V.
Burke, William James	Springfield	81 Pleasant Street.
Campbell, Donald Hays	Shirley	10 South College.
Campion, Thomas Joseph	Amherst	83 Pleasant Street.
Cann, Marvin Francis	Lynn	70 Lincoln Avenue.
Capone, Mario	Chelsea	4 North College.
Chapman, Dorothy Ann	Newtonville	Abigail Adams House.
Clark, Harold Eugene	Montague	East Experiment Statio
Cook, Albert Cairnes	Waverley	12 North College.
Cooke, Dorothy Mabel	Richmond	Abigail Adams House.
Crowley, Francis Jeremiah	Amherst	20 Woodside Avenue.
Cunningham, James Hugh	Atlantic	11 South College.
Davis, Richard Jackson	Arlington	7 North College.
Dean, Carolyn	Utica, N. Y.	Abigail Adams House.
Denton, Ian Oliphant	Attleboro	29 Fearing Street.
Draper, William Hill, Jr.	Watertown	Kappa Sigma.
Dresser, Horatio Malcolm	South Hadley	Alpha Sigma Phi.
Duffield, Susan Muir	Detroit, Mich.	Abigail Adams House.
Elliott, Lawrence William	Waltham	16 South College.
Estes, Wendall Eames	West Duxbury	Care of Mr. Everson.
Ewer, Seth Judson	Leyden	13 Phillips Street.
Ferguson, Thomas Wells, Jr.	Newton Highlands	Theta Chi.
Flemings, Frederic James	Sharon	13 Phillips Street.
Forest, Joseph Henry	Arlington	Alpha Gamma Rho.
Fox, Robert Leo	Ware	Q. T. V.
Frese, Paul Frederick	Waltham	42 Lincoln Avenue.
Galvin, William Frederick[2]	Greenfield	15 North College.
Gifford, Charles Edwin[1]	Sutton	Kappa Sigma.
Goldberg, Louis Noah	Wilmington	15 South College.
Goldberg, Maxwell Henry	Stoneham	13 South College.
Golledge, Robert James	Cheshire	Sigma Phi Epsilon.
Gwynn, Arthur William	Roslindale	Q. T. V.
Hall, Barbara Janet	Great Barrington	Abigail Adams House.
Hall, Harriet Phoebe	Great Barrington	Abigail Adams House.
Hall, John Stanley	Lynn	Alpha Gamma Rho.
Harris, Edmund George	Baldwinsville	Kappa Gamma Phi.
Hemenway, Truth Mary	Holden	Abigail Adams House.
Hodson, Alexander Carlton	Reading	Sigma Phi Epsilon.
Holland, Bertram Holbrook	Millis	6 Nutting Avenue.
Homeyer, Frank Fuller	Wellesley Farms	Theta Chi.
Howland, Walter Morton	Conway	44 Sunset Avenue.
Hyde, William Eaton	Amherst	55 Pleasant Street.
Hynes, Ralph William	Holyoke	81 Pleasant Street.
Ingraham, Mary	Millis	Abigail Adams House.
Isham, Paul Dwight	Hampden	Q. T. V.
Kane, Thomas Joseph	Westfield	Q. T. V.
Karrer, Robert Joseph	Hingham	Phi Sigma Kappa.

[1] Candidate for degree of B.Voc.Agri.
[2] Admitted on probation, entrance record not clear.

Kennedy, Wellington Waterloo, 3d,	Red Bank, N. J.	Kappa Epsilon.
Kidder, Dana Judson, Jr.	Fayville	Theta Chi.
Kimball, John Adams	Littleton	9 North College.
Lane, Donald Ricker	Brockton	7 North College.
LaPrise, Albert Joseph	Great Barrington	9 South College.
Lassiter, Elizabeth Ruth [1]	Holyoke	Abigail Adams House.
Laubenstein, Karl George	Maynard	8 North College.
Laun, George Christian	Waterville, Conn.	70 Lincoln Avenue.
Lawrence, Julia Ruth	Springfield	Abigail Adams House.
Leonard, Charles Smith	Chicopee	Lambda Chi Alpha.
Leonard, Dorothy Luella	West Springfield	Abigail Adams House.
Lincoln, Robert Alexander	Hingham	Theta Chi.
Little, Margaret Adams	Newburyport	Abigail Adams House.
Loring, Douglas Winthrop	Springfield	6 Nutting Avenue.
Marsh, Edwin Elliott	Pittsfield	Q. T. V.
Marston, Leon Chester, Jr. [1]	Brockton	27 Fearing Street.
Marx, Walter Herman	Holyoke	9 South College.
McEwen, Leslie Irving	Winchester	9 North College.
McQuire, Walter Kenneth	Whitinsville	10 North College.
Moore, Ethan Dana	West Springfield	Alpha Gamma Rho.
Morey, Elizabeth Alma	Bolton	Abigail Adams House.
Moriarty, Robert Earl	Monson	21 Fearing Street.
Morland, Harold Laurud [2]	Islington	86 Pleasant Street.
Mulhern, Daniel Joseph	Roslindale	6 North College.
Murch, Ralph Gordon	Holliston	8 North College.
Noble, Frank Freeman [2]	Fall River	Q. T. V.
Nutting, John Lyman	West Berlin	3 Fearing Street.
O'Connor, Margaret Merrill	Haverhill	Abigail Adams House.
Owers, Robert Hammond	Taunton	Alpha Gamma Rho.
Panzica, Josephine	Boston	Abigail Adams House.
Pickett, Thomas Austin	Beverly	84 Pleasant Street.
Pincombe, Caroline Louise	North Adams	Abigail Adams House.
Plantinga, Oliver Samuel	Amherst	North East Street.
Plantinga, Sarah Theodora	Amherst	North East Street.
Pratt, Marjorie Johnson	Dalton	Abigail Adams House.
Prentiss, Adelaide Hatheway	Plainfield, Conn.	Abigail Adams House.
Preston, Charles Putnam	Danvers	Kappa Sigma.
Preston, Stanley Nichols	Danvers	Kappa Sigma.
Proctor, Harriet Ellise	South Weymouth	Abigail Adams House.
Purrington, Rachel Elizabeth	Shattuckville	Abigail Adams House.
Quinn, John Francis	New Bedford	10 North College.
Redgrave, Arnold Ide	Hopedale	Phi Sigma Kappa.
Reed, Roland Ellsworth	Greenfield	16 North College.
Rice, Cecil Curtis	Spencer	Stockbridge Hall.
Ricker, Albion Barker	Turner, Me.	7 North College.
Roper, Hartwell Eveleth	Closter, N. J.	Farmhouse.
Rourke, Charles Henry	Framingham	8 Kellogg Avenue.
Ryan, Edward Parker [2]	Swampscott	Kappa Gamma Phi.
Schappelle, Newell Allen	Hamburg, Pa.	25 Amity Street.
Schmidt, Ernest John	Longmeadow	6 Nutting Avenue.
Simmons, Oliver Dorrance	Beverly	3 Fearing Street.
Smith, Charles James, Jr.	North Wilmington	15 Phillips Street.
Smith, Leslie Rockwell, Jr.	Hadley	Hadley.
Smith, Walter Russell	Holden	Alpha Gamma Rho.
Southgate, Barbara Willson	Sea View	Abigail Adams House.
Spencer, Ernest Leavitt	Lowell	83 Pleasant Street.
Stratton, Frank	Lawrence	86 Pleasant Street.
Sullivan, Charles Burke [2]	Fall River	Care of Mr. Everson.
Thomas, Howard	Holyoke	16 North College.
Thompson, Frances Clarinda	Amherst	Mt. Pleasant.
Thompson, Leonard Lewis	Greenfield	12 North College.
Trull, Henry Bailey	Lowell	Sigma Phi Epsilon.
Tufts, Warren John	Jamaica Plain	1 North College.
Tulloch, George Sherloch	Bridgewater	Q. T. V.
Tuttle, Alden Parker	South Milford	Baker Place.
Van Hall, Walter Bernhardt	Roslindale	Alpha Sigma Phi.
Voetsch, George Bernard	Greenfield	Sigma Phi Epsilon.
Washburn, Edward Allen [1]	Marion	Alpha Sigma Phi.
Weiler, Grace Elaine	Amherst	34 Main Street.
Welch, Richard Francis	Salem	Theta Chi.
Wendell, George Goodwin	Belmont	21 Amity Street.
White, Edwin Searles	Worcester	5 North College.
Wilcox, Philip Emerson	Rockland	70 Lincoln Avenue.
Wilder, Edwin Arthur	Sterling Jct.	83 Pleasant Street.
Williams, Florence Dorothea	East Norton	Abigail Adams House.
Williams, Lloyd George	Pittsfield	Kappa Epsilon.

Class of 1929.

Adams, Buell Thompson	Dalton	32 North Prospect Street.
Adams, Harold Sweetnam [1]	Whitinsville	6 Nutting Avenue.
Adams, Stephen [2]	Easthampton	32 North Prospect Street.
Alberti, Francis Daniels	Greenfield	10 Nutting Avenue.
Ansell, Harold King	Grantwood, N. J.	73 Pleasant Street.
Avery, Blanche Deane	Greenfield	Abigail Adams House.
Bailey, Stanley Fuller	Middleborough	21 Fearing Street.
Barr, Charles Wesley	Pittsburgh, Pa.	The Davenport.

[1] Admitted on probation, entrance record incomplete.
[2] Candidate for degree of B.Voc.Agri.

Bartlett, Irene Lawrence	Brattleboro, Vt.	Abigail Adams House.
Bates, Ira Spaulding	Whitinsville	6 Nutting Avenue.
Benjamin, Hazel Elvira	Ashfield	Abigail Adams House.
Bern, Philip	Dorchester	15 South College.
Bertenshaw, Edith Louise	Fall River	Abigail Adams House.
Black, Chesley Leman	Reading	97 Pleasant Street.
Blaisdell, Matthew Louis	South Ashfield	Sunderland.
Bliss, Lois Anne	Springfield	Abigail Adams House.
Bond, James Eaton, Jr.	South Lancaster	81 Pleasant Street.
Bowie, Robert Lester	East Milton	6 Phillips Street.
Brackley, Floyd Earle	Strong, Me.	15 Fearing Street.
Burgess, Emory Dwight	Melrose Highlands	86 Pleasant Street.
Canney, George Gridley	South Hadley	81 Pleasant Street.
Carruth, Laurence Adams[1]	Worcester	15 Phillips Street.
Carter, Warner Harris	Amherst	Amherst, R. F. D.
Chadwick, John Shore	Worcester	27 Fearing Street.
Chapin, Alice Streeter	Sheffield	Abigail Adams House.
Chapin, Horace Ralph	Chicopee Falls	51 Amity Street.
Charleston, George Robinson	Everett	101 Pleasant Street.
Cleaves, Charles Shepley	Gardner	9 Fearing Street.
Clements, Charles Robert Crofford	Melrose	86 Pleasant Street.
Collins, Edgar Winslow	East Brimfield	10 Nutting Avenue.
Comins, Lawrence Albert	Millers Falls	3 Nutting Avenue.
Cook, Florence Mary	Hadley	Amherst, R. F. D. 1.
Copson, Harry Rollason	Easthampton	18 Chapman Ave., Easthampton.
Coukos, Andrew[1]	Lynn	21 Pleasant Street.
Cox, Adelbert Winters	Framingham	7 East Pleasant Street.
Crowley, Dennis Michael	Boston	6 North College.
Davis, Donald Austin	Bedford	21 Fearing Street.
Davis, Kendall Edgar	Springfield	9 Fearing Street.
Dawe, Ralph Turner	North Adams	Theta Chi.
Day, William Albert Palmer	Watertown	30 Fearing Street.
Devine, John Warren	Arlington	21 Fearing Street.
Dutton, George Wallace	Carlisle	3 Allen Street.
Dyer, Arnold Walton	Falmouth	86 Pleasant Street.
Edson, William Gordon[1]	East Braintree	84 Pleasant Street.
Egan, William Ambrose	Springfield	Care of Prof. Banta, Sunset Avenue.
Elliot, Davis Haskins	Dartmouth	6 Phillips Street.
Fairbairn, William Richard[1]	Rockland	66 Pleasant Street.
Faulk, Ruth Adelaide	Brockton	Abigail Adams House.
Flint, George Bemis	Lincoln	81 Pleasant Street.
Fonseca, Martin Goodman	Boston	Farmhouse.
Fontaine, Mildred	Fall River	Abigail Adams House.
Foster, Edward Clark	Haydenville	Haydenville.
Foster, Thomas William	Sherborn	7 East Pleasant Street.
Frost, Charles Austin	Belmont	15 North College.
Gagliarducci, Anthony Lewis[2]	Springfield	Care of Prof. Banta, Sunset Avenue.
Gasper, Frank[1]	Dighton	Care of Prof. Sears.
Giandominico, Stephen	Walpole	7 Phillips Street.
Goodwin, Laurence Hunter[1]	Wollaston	84 Pleasant Street.
Gordon, George Bauchop	West Newton	44 Sunset Avenue.
Graves, Arthur Hall[1]	Shelburne Falls	3 Fearing Street.
Graves, Lyman William	Conway	9 Mt. Pleasant.
Grover, Richard Whiting	Cambridge	83 Pleasant Street.
Hammond, Marjorie Allerton	Onset	Abigail Adams House.
Harrington, Mary Eileen	Holyoke	Abigail Adams House.
Harris, Robert Henry	Greenfield	53 Lincoln Avenue.
Hawley, Guila Grey	Westfield	Abigail Adams House.
Henderson, Everett Spencer	West Hartford, Conn.	3 Nutting Avenue.
Hinchey, Anne Elizabeth	Palmer	Abigail Adams House.
Hintze, Roger Thomas	Amherst	Aggie Inn.
Horan, Timothy Joseph	Whitinsville	4 North College.
Hotchkiss, Irving Parsell	Green's Farm, Conn.	Farmhouse.
Howard, Martin Stoddard	Northfield, Vt.	97 Pleasant Street.
Howe, Frank Irving, Jr.	Norfolk	17 Phillips Street.
Hunter, Walter Gordon	South Sudbury	13 North College.
Huss, Miriam Hall	Newton Centre	Abigail Adams House.
Johnson, Alice Luvanne	Holden	Abigail Adams House.
Johnson, Clifton Russell[2]	Worcester	5 North College.
Jones, Janet Mayo	Amherst	10 Woodside Avenue.
Jones, Leroy Osgood	Greenfield	12 South College.
Kane, Mary Catherine	Holyoke	Abigail Adams House.
Kay, John Reid	Boston	16 South College.
Kelleher, Edmund Louis	West Roxbury	6 North College.
Kelley, Charles Edward	Dalton	32 North Prospect Street.
Kingman, Harriet Cushman	Natick	Abigail Adams House.
Kinney, Asa Foster	South Hadley	42 McClellan Street.
Kreienbaum, Roman Albert	Bridgewater	83 Pleasant Street.
Ladas, Constantine Pericles[2]	Boston	Pease Avenue.
Lane, Thomas Edward	East Boston	97 Pleasant Street.
Lincoln, Margaret Elizabeth	Shirley	Abigail Adams House.
Love, Elizabeth Perry	Auburn	Abigail Adams House.
Lyman, Warren Hillsgrove[1]	Florence	21 Fearing Street.
Lynch, Elizabeth Anne	Easthampton	Abigail Adams House.
Macione, Augustus Paul	Peabody	3 Fearing Street.

[1] Candidate for degree of B.Voc.Agri.
[2] Admitted on probation, entrance record incomplete.

anchester, Erford Dayton	Hyde Park	75 Pleasant Street.
ansur, Paul Buck	Westminster	– –
arsh, Kendall Howe	Holden	6 Nutting Avenue.
art, Willis Hilliard [1]	Richmond	13 North College.
cKay, Catherine Mary	Newtonville	Abigail Adams House.
cKittrick, Kenneth Fraser	Boston	16 South College.
ills, Taylor Mark	Boston	16 South College.
insuk, Henry George	Brooklyn, N. Y.	15 Fearing Street.
organ, Vernon Dwight	South Yarmouth	86 Pleasant Street.
orrison, Leonard William	Monson	50 Northampton Road.
orse, Emily Albertina	Waban	Abigail Adams House.
urphy, Charles Daniel	Hadley	Hadley.
ash, Robley Wilson	Abington	11 South College.
ewell, Florine Elizabeth	Westborough	71 Main Street.
chols, Edward Holyoke	Montpelier, Vt.	83 Pleasant Street.
ckerson, Ralph Francis	Attleboro	23 East Pleasant Street.
tkiewicz, Boleslaw	Holyoke	Kappa Epsilon.
Leary, William Joseph	Northampton	2 Sunrise Avenue.
ckard, Faith Evelyn	Windsor	Abigail Adams House.
rrish, Ruth Harriet	Great Barrington	Abigail Adams House.
ulson, John Edward	Holyoke	9 South College.
ase, Holton Stebbins	Hampden	30 Fearing Street.
rkins, Esther Janet	Easthampton	112 Pleasant Street, Easthampton.
rry, Kenneth William	Holliston	3 Nutting Avenue.
inney, William Rolland	Willimansett	51 Amity Street.
umer, Paul Raymond	Adams	17 Phillips Street.
zzi, Joseph John	North Adams	13 Phillips Street.
outy, Earl Clinton	Mittineague	75 Pleasant Street.
nney, Perry Sidney	Ashfield	44 Sunset Avenue.
plus, Harry Edward	Agawam	– –
yno, Carlton George	Gilbertville	45 Fearing Street.
es, Robert Drake	Newtonville	Alpha Sigma Phi.
gan, John Michael	Holyoke	83 Pleasant Street.
ynolds, Arthur Raymond	Florence	13 Phillips Street.
ce, Louise Trask	Greenfield	Abigail Adams House.
ch, Kenneth Merton	Malden	83 Pleasant Street.
chards, Lawrence Edward	Dalton	32 North Prospect Street.
chardson, Evan Carleton	Millis	Care of Mr. Everson.
bertson, William Brunner	Port Chester, N. Y.	4 Nutting Avenue.
oney, Charles Louis	Chester Depot, Vt.	15 Fearing Street.
we, Miriam Louise	Bolton	Abigail Adams House.
dquist, Birger John	Dorchester	83 Pleasant Street.
tan, Huntington	Wilmington, Vt.	North Hadley.
rgent, Carmeta Elizabeth	Shrewsbury	Abigail Adams House.
rgent, Leonard Fessenden Everett	Greenfield	12 South College.
ars, Louis Alf	Ashby	53 Lincoln Avenue.
ttele, Karl Outhank	Arlington Heights	42 McClellan Street.
vrens, Harvey William	Greenfield	53 Lincoln Avenue.
eridan, James Walter	Bolton	86 Pleasant Street.
ockro, Harold Joseph	Hadley	Hadley.
uman, Ernest Clark	Malden	15 Hallock Street.
vert, Gladys Elizabeth [2]	Worcester	Abigail Adams House.
ick, Grace Gertrude	Allston	Abigail Adams House.
ith, Bessie May	Somerville	Abigail Adams House.
ith, John Meade, Jr.	Greenfield	Tillson Court.
ell, Robert Sinclair	Southbridge	Care of Mr. Kneeland.
per, Carolyn Emma	Shelburne Falls	Abigail Adams House.
uthwick, Walter Edward	Clinton	75 Pleasant Street.
ies, Naomi Jeanne	Holyoke	Abigail Adams House.
anisiewski, Peter Francis	Amherst	Triangle Street.
eere, Phillips Bradley	Chepachet, R. I.	4 Nutting Avenue.
einbugler, Elizabeth Anne	Brooklyn, N. Y.	Abigail Adams House.
llivan, John Ayer	Medford	70 Lincoln Avenue.
rr, Roy Simpson	Gloucester	17 Phillips Street.
fft, Volney Vanderneer	Ashby	6 Nutting Avenue.
ayer, Frederick Daniels, Jr.	Shrewsbury	75 Pleasant Street.
dd, Douglas Howard	Taunton	83 Pleasant Street.
mpkins, Earle Alexander	Easthampton	7 Phillips Street.
urtellot, Clarence Sampson	Providence, R. I.	83 Pleasant Street.
evett, Moody Francis	Milford	66 Pleasant Street.
fts, Helene Maevelyn	Jamaica Plain	Abigail Adams House.
rtanian, Dickran	Springfield	11 North College.
rner, Charles Edward	Millers Falls	3 Nutting Avenue.
alkden, Charles Edward	Swansea	3 Allen Street.
alker, Lewell Seth, Jr.	Amherst	19 Phillips Street.
ard, Stuart Houghton	Greenfield	66 Pleasant Street.
arner, Helen Louise [1]	Williamstown	Abigail Adams House.
eaver, Edward Leigh [2]	Enfield	R. F. D. 3, box 64c.
ebber, Dana Otis	Montague	97 Pleasant Street.
hite, Lawrence Henry	Amherst	42 High Street.
hitten, Russell Rutherford	Melrose	86 Pleasant Street.
hittle, Doris Evelyn	Worcester	Abigail Adams House.
oodbury, John Sargent	Fitchburg	9 Fearing Street.
ung, Clarence Dow	Springfield	97 Pleasant Street.
ung, Edward Henry	Northampton	233 Elm Street, Northampton.
linski, John Blaise, Jr.	Holyoke	83 Pleasant Street.

[1] Admitted on probation, entrance record incomplete.
[2] Candidate for degree of B.Voc.Agri.

Registered after the Catalogue for 1924 was published.

Class of 1928.

Wong, Theodore Kaiping	China.

Special Student.

Davenport, William Herbert	Amherst.

Special Students.

Adshead, Mona	Auburn	Abigail Adams House.
Coveney, John Joseph	Amherst	Amherst, R. F. D. No.
Delaney, Rose Margaret	Holyoke	Draper Hall.
Hays, (Mrs.) Florence C.	Amherst	Oneacre.
Pickering, (Mrs.) W. S.	Amherst	86 Pleasant Street.
Pierpont, Mildred	Amherst	28 Pleasant Street.
Pushee, George Frederick	Amherst	North Amherst.
Tamada, Kitaro	Japan	97 Pleasant Street.
Thayer, Charles Hiram	Amherst	South Amherst.

Geographical Summary.

Massachusetts	521	Wisconsin	
Maine	3	South Carolina	
New Hampshire	1	Indiana	
Vermont	6	Virginia	
Colorado	1	Utah	
Connecticut	9	South Dakota	
Rhode Island	5	Hawaii	
New York	8	Japan	
New Jersey	4	Russia	
Pennsylvania	2	Asia Minor	
Florida	1		
Michigan	1	Total	5

Summary by Classes.

Class.	Men.	Women.	Total.
Graduate students	42	5	47
Seniors, 1926	90	15	105
Juniors, 1927	83	11	94
Sophomores, 1928	110	28	138
Freshmen, 1929	140	39	179
Specials	4	5	9
Totals	469	103	572

Short Course Enrollment.

Two-Year Graduates, 1925.

Ackerman, Randolph Spofford	Salisbury.
Ansell, Harold King	Grantwood, N. J.
Arnold, Elliot Frank	Woburn.
Baker, Willis	Boston.
Berry, Harold Edward	Natick.
Breckenridge, Earl	Andover.
Buswell, Albert Henry	Belmont.
Caless, Thomas Winfred	Westfield.
Chilson, Dorothy Lila	Huntington.
Cooper, Janice Marie	Westfield.
Crooks, Donald Lovell	North Brookfield.
Crooks, Harold Baker	North Brookfield.
Cummings, Frank James	North Adams.
Dennett, James Winslow	Plympton.
Derby, Benjamin Edward	Concord Junction.
Devine, Theodore Joseph	Taunton.
Frawley, Earl Alton	New Bedford.
Frieh, George Joseph	Boston.
Fuller, Douglas William	Southampton, N. Y.
Griswold, Christine Mueller	Springfield.
Hall, Ivory Arthur	South Portland, Me.
Harrington, Donald Francis	Framingham.
Hartney, Clyde Clarence	Athol.
Hayn, Ernest Morris	Springfield.
Johnson, Mary	Boston.
Jordan, William Duncan	Somerville.
Kane, John Vincent	Lenox.
Kingsbury, Carl Manning	Woodville.
Lacombe, Albert George	Beverly.
Lawton, Clarence Copeland	Worcester.
Matuleurcz, Andrew Joseph	Orange.
Mecum, Ethel Doris	Becket.
Mellor, John Albert	Somerville.
Merryman, Rebecca Eastman	Bradford.
Montague, Guilford	South Deerfield.
Murphy, Thomas Patrick	Woburn.
Myers, Morley Whitfield	Hingham.
Norell, John	Sunderland.
O'Hara, Francis Edward	Worcester.
Patterson, Harold Taylor	Barre.
Payne, Donald Tubbs	Dunstable.
Pickard, Cyrus Warren	Concord Junction.
Pomeroy, Allen Bradford	Longmeadow.
Power, James Anthony	Arlington.
Severance, Charles Almon	Moultonboro, N. H.
Stow, Basil Tenney	Stow.
Thompson, Kenneth Horatio	Revere.
Tower, Lester Milton	South Weymouth.
Welch, John D.	Northfield, Vt.
Woodruff, Webster Clinton	Fitchburg.

Second Year Two-Year Students, 1925–26.

Adams, Samuel S.	Swansea	97 Pleasant Street.
Adams, Charles I.	Amherst	29 Main Street.
Alcott, Elverton Hunting	Brookline	A. T. G., North College.
Ames, Bessie Bell	Center Marshfield	Abigail Adams House.
Anderson, Frederick	Grafton	81 Pleasant Street.
Apelquist, Philip Eugene	Orange	Baker Lane.
Bassett, Sherrold Emerton	Everett	86 Pleasant Street.
Belcher, Ranald Ashley	North Abington	North College.
Blood, Charles Andrew Fletcher	Pepperell	Kolony Klub.
Bradley, Howard Courtland	Seekonk	9 Fearing Street.
Brown, Charles Franklin	Worcester	84 Pleasant Street.
Bumstead, Augustine	Medford	14 McClellan Street.
Burgevin, Paul Louis	Port Chester, N. Y.	75 Pleasant Street.
Callander, Murray Austin	Boston	97 Pleasant Street.

Chaffee, Curtis Walter	Enosburg Falls, Vt.	Y. M. C. A., Holyoke.
Clapp, Irving Miller	Northampton	North Amherst, care of Mr. Sheffield.
Clark, Stewart Floyd	Conway	9 Mt. Pleasant.
Cogswell, Sarah Ellen	Westborough	Abigail Adams House.
Crocker, Ralph Herman	Holliston	Kolony Klub.
Davidson, Henry Wilbur	Auburn	A. T. G., North College.
Davis, Charles Ellsworth	North Adams	A. T. G., North College.
DeLano, Fred Lewis	Richmond Hill, N. Y.	Kolony Klub.
DeLorenzo, Joseph	Kingston	35 East Pleasant Street.
Desrosiers, Adolphe Biron	Orange	A. T. G., North College.
Dillon, Frank Edward	New Bedford	Kolony Klub.
Dingley, Elmer Albian	Sherborn	3 Fearing Street.
Donnelly, Edward Boyce	Waltham	73 Pleasant Street.
Foster, William Edward	Ipswich	South College.
Fullam, Kenneth Bullord	North Brookfield	15 Hallock Street.
Goldthwaite, Ernest	Dunstable	Baker Lane.
Hamilton, Thomas Arnold	Fair Haven, Vt.	North College.
Hawes, Ralph Edmund	Sudbury	A. T. G., North College.
Hayden, Charles Ernest	Newtonville	4 Chestnut Street.
Herron, Frank Robert	Greenfield	The Davenport.
Hess, Frank Wesley	Springfield	A. T. G., North College.
Humphrey, Leo Harris	Medford	14 McClellan Street.
Hyde, Gerald	Buzzards Bay	Kolony Klub.
Johnson, Gunnar Theodore	Leicester	A. T. G., North College.
Johnson, Tage Fred	Milton	Kolony Klub.
Kaakinen, Theodore	Fitchburg	Kolony Klub.
Knox, Barbara Howard	Taunton	Abigail Adams House.
Ladd, Joseph Mark	Worcester	4 Hallock Street.
Lahey, Jeremiah Joseph	Plymouth	29 Lincoln Avenue.
Leoncini, Louis John	Hopedale	35 East Pleasant Street.
MacCulloch, William	Salem	Kolony Klub.
Maclean, Theodore Elwin	Spencer	35 East Pleasant Street.
Markert, Ernest Frederick	Amherst	West Street.
Massa, Andrew Louis	East Boston	A. T. G., North College.
Mathews, George Williams	Boston	Kolony Klub.
Maynard, Walter P.	Hopedale	Baker Lane.
McCloskey, Francis Frederick	Winchester, N. H.	35 East Pleasant Street.
McCurdy, John	Gardiner, Me.	6 Kellogg Avenue.
Meeker, Alice Maude	Ludlow	12 North East Street.
Mellen, James Dwight	Athol	A. T. G., North College.
Miller, Edward Dowing	Lee	Kolony Klub.
Nash, Alexander Allaire	Mattapoisett	Kolony Klub.
Newhall, Benjamin Weston	Danvers	84 Pleasant Street.
Nutter, Richard Louis	Melrose	20 Spring Street.
Olympio, Alerico Octaviano	Lome, Togoland, W. C. Africa	101 Pleasant Street.
Parker, Charles Wilson	East Orleans	Eames Avenue.
Parsons, Philip Hinde	Manchester	18 Nutting Avenue.
Pearse, William Thomas	Rockland	— —
Prouty, Homer Spooner	Furnace	86 Pleasant Street.
Putnam, Frank Wendell	West Newton	86 Pleasant Street.
Richards, Foster Herbert	Lowell	North College.
Riley, Ernest Francis	Dedham	97 Pleasant Street.
Root, Worth Stewart	Colrain	97 Pleasant Street.
Rowell, Elisabeth Johnson	Groton	Abigail Adams House.
Safran, Mayer	Malden	56 Pleasant Street.
Sawyer, Roland Willard	Groton	A. T. G., North College.
Shelnut, Charles Francis	South Boston	North College.
Smith, Edith Caswell	Wakefield	Abigail Adams House.
Sullivan, Maurice Laurence	Peabody	84 Pleasant Street.
Tonseth, Richard G.	Lunenburg	North College.
Tribe, Stanley Gordon	Somerville	18 Nutting Avenue.
Truelson, Stanley Dunham	Somerville	3 Nutting Avenue.
Varnum, William Parker	Collinsville	1 Cottage Street.
Walker, Roger Francis	South Sudbury	86 Pleasant Street.
West, Roger Edward	Hadley	Hadley.
Wetherbee, Roger Frederick	Townsend Harbor	108 Pleasant Street.
Whitcomb, Janet	Haverhill	Abigail Adams House.
Wilson, Herbert Ralph	Chelsea	A. T. G., North College.
Wood, Helen May	Stoughton	Abigail Adams House.
Yocum, Margaret Gardner	Wooster, Ohio	Abigail Adams House.

First Year Two-Year Students, 1925–26.

Aalto, Nestor Armas	Osterville	23 East Pleasant Street.
Anderson, Francis Joseph	Everett	108 Pleasant Street.
Anderson, Ralph Welman	Dorchester	Baker Lane.
Atwood, Donald Meredith	North Abington	6 Phillips Street.
Bennett, Dorothy Dunbar	Watertown	Abigail Adams House.
Bird, James Henry	West Roxbury	South College.
Boelsma, Harmen	Hingham	North Amherst, care of Mr. Sheffield.
Bothfeld, Francese Ray	Harvard	Abigail Adams House.
Bradley, Charles Luther	East Lee	Baker Lane.
Brown, Oscar Joseph	Pittsfield	89 Main Street.
Bullard, Rachel Althea	Orange	Abigail Adams House.
Burrill, Arthur Webster	Wellesley	2 Allen Street.
Burt, Percy Leighton	Vineyard Haven	4 Chestnut Street.
Caffrey, William James	Cromwell	35 East Pleasant Street.

Callahan, Kathleen Sara	Dorchester	Abigail Adams House.
Chamberlain, Chedo	Newtonville	5 Sunset Avenue.
Cole, Sydney Herbert	Holyoke	17 Kellogg Avenue.
Corbett, Joseph Anthony	Charlestown	14 McClellan Street.
Cover, Frederick Brooke	Lowell	1 Cottage Street.
Doubleday, Helena Anna	North Dana	Abigail Adams House.
Ducharme, Daniel Bazel	Willimansett	525 Chicopee Street, Willimansett.
Duclos, Milton Huggett	West Somerville	6 Phillips Street.
Eastman, Robert Emil	Boston	12 Chestnut Street.
Elder, Roy Wentworth Rockwell	Waverley	56 Pleasant Street.
Farrell, Anthony Patrick	Hyde Park	South College.
Felton, Lindley	Marlborough	8 Kellogg Avenue.
Fitzgerald, Elmer Smith	Leominster	68 Lincoln Avenue.
Flight, George James	Jamaica Plain	15 Hallock Street.
Frothingham, Walter Dudley	Flushing, L. I., N. Y.	3 Nutting Avenue.
Fuller, Lucia Baldwin	Belmont	Abigail Adams House.
Gale, Merton Stuart	Gardner	56 Pleasant Street.
Gay, Edward Ernest, Jr.	Belchertown	8 Kellogg Avenue.
Gibbs, John Edward	Nantucket	5 Sunset Avenue.
Hall, George Winston	Dudley	86 Pleasant Street.
Hallbourg, Robert Francis	Westfield	17 Kellogg Avenue.
Hannigan, Michael Joseph	Milford	Baker Lane.
Harris, Mavis Hazel	Hudson	Abigail Adams House.
Hayward, Francis Dean	Holden	6 Nutting Avenue.
Holland, Leslie Clayton	Holyoke	17 Kellogg Avenue.
Holt, Amos Howard	Norridgewock, Me.	M. A. C. Bungalow.
Hull, Emily Julia	Agawam	Abigail Adams House.
James, Donald Wilcox	Upton	35 East Pleasant Street.
Kane, Harry Busse	Amsterdam, N. Y.	East Pleasant Street, care of Mr. Toole.
Kelley, William Edward	Amherst	Depot Street.
Kenyon, Bernard Holden	Newtonville	5 Sunset Avenue.
King, Arthur Hamilton	Woburn	35 East Pleasant Street.
Ketchen, Andrew Gilmore	Belchertown	8 Kellogg Avenue.
Larson, Carl Philip	Hampden	30 Fearing Street.
Lovejoy, Benjamin Edward	Framingham	6 Phillips Street.
Marks, Stanley Emery	Lynn	35 East Pleasant Street.
Mason, David	Brookline	9 Phillips Street.
Mason, George Arthur	Somerville	8 Allen Street.
Mason, Harold C.	Princeton	Eames Avenue, care of Mrs. M. E. Stone.
May, Arthur Howard	Bernardston	5 Tillson Court.
Nicolai, Mario	Somerville	Baker Lane.
Nilsson, Gustaf Carl	Worcester	60 Pleasant Street.
O'Brien, James John	Amherst	Whitney Street.
O'Neil, Eugene Francis	Amherst	Whitney Street.
Otto, Edmund	West Springfield	86 Pleasant Street.
Oxton, Ralph Ashby	Cambridge	17 Kellogg Avenue.
Parker, Alfred Henry	East Pepperell	7 McClellan Street.
Peabody, Samuel Sumner	Manchester	15 Fearing Street.
Philadelphus, Angelos Gabriel	Melrose	Eames Avenue, care of Mrs. Stone.
Phinney, Edward Barlow	Pocasset	4 Chestnut Street.
Pickard, Ashley Houghton	Littleton	8 Allen Street.
Pitt, Charles Randall	Bridgeport	60 Pleasant Street.
Plude, Alfred Edward	Somerville	12 Chestnut Street.
Post, Philip Malcolm	Worcester	31 East Pleasant Street.
Prendergast, Francis Thomas	Hadley	Middle Street, Hadley.
Price, Ruth	North Attleborough	Abigail Adams House.
Randolph, Marion Gold	Dwight	Abigail Adams House.
Rogers, Norman Wright	Newtonville	33 East Pleasant Street.
Roy, John Plimpton	North Adams	35 East Pleasant Street.
Russ, Sherman Wilder	Sunderland	Sunderland.
Ryan, Bernard Joseph	Pittsfield	4 Hallock Street.
Scott, Raymond Earle	Pepperell	7 McClellan Street.
Scott, Walter Dingley	Woburn	56 Pleasant Street.
Sennott, Miriam Katherine	Boston	Abigail Adams House.
Shepard, Lucius Colton	Princeton	35 East Pleasant Street.
Shorey, Herbert Moulton	Melrose	86 Pleasant Street.
Sime, Frederick Oliver	North Weymouth	86 Pleasant Street.
Smith, Frank Pellman	Somerville	8 Allen Street.
Smith, Ralph Wesley	Hyde Park	9 Phillips Street.
Smith, Roland Whipple	Medford	Baker Lane.
Smyth, James William	Boston	8 Kellogg Avenue.
Spalding, Jacob Franklin	Watertown	30 Fearing Street.
Stewart, Harold Edward	West Boylston	North Amherst, care of Mr. Archibald.
Strong, Arthur Eugene	Amherst	13 Hallock Street.
Sweet, Howard Arthur	Norton	North Amherst, care of Mr. Archibald.
Viale, Mark Raymond	Pittsfield	4 Hallock Street.
Vincent, Archer William	Townshend, Vt.	Baker Lane.
Waldo, Theodore Elias	Boylston Center	Baker Lane.
Warren, Lawrence Philip	Westborough	86 Pleasant Street.
Watson, Neil Buster	Flint, Mich.	86 Pleasant Street.
Weeks, Janet	Somerville	Abigail Adams House.
Whitcomb, Oliver Adams	Littleton	8 Allen Street.
Whithed, Morton Ernest	Bernardston	3 Nutting Avenue.
Whitmore, Edwin Ervin	Brockton	60 Pleasant Street.

Wile, Ira Rigby	New York, N. Y.	24 Pleasant Street.
Wilson, Bennett Joshua	Boston	101 Pleasant Street.
Winslow, Rex Parker	Worcester	15 Phillips Street.
Woodbury, Donald Frederick	Sunderland	Sunderland.
Wright, Wendell Philips	Danvers	15 Fearing Street.
Young, Edwin Ralph	Worcester	North Amherst, care of Mr. Archibald.
Zaik, Frank Leo	East Brookfield	8 Kellogg Avenue.

Vocational Poultry Course, 1925.

Hayward, Richard Homer	Reading	30 Fearing Street.
Lewis, John Grant	Boston	30 Fearing Street.
Lind, Edwin Gustof	Orange	Poultry Plant.

Winter School, 1925.

Abbott, G. Richard	Andover.
Adams, Nellie D.	Wollaston.
Aiken, Harold	East Bridgewater.
Andrew, D. Kilton	Nashua, N. H.
Andrews, Chandler B.	Richmond.
Baker, Marshall	Amherst.
Barbey, John	Montmollin, Switzerland.
Barnard, Merriman	Warwick.
Beauregard, L. M.	Saco, Me.
Bell, Mrs. Ruth E.	Alstead, N. H.
Buckhart, Wm. A.	South Hadley.
Carmalt, Woolsey	Friendsville, Pa.
Carroll, Frank A.	Pittsfield.
Casey, Mary F.	Lawrence.
Chace, Emerson R.	Westport.
Clark, Howard M.	Lyonsville.
Colby, E. C.	Everett.
Colgan, M. R.	Newton Highlands.
Crane, Rosemary	Dalton.
Cross, Roger L.	North Grafton.
Cutler, Albert B.	Boylston.
Daley, John P.	Beverly.
Dodge, W. H.	Leominster.
Dupee, Allan L.	Roslindale.
Dushame, Harold	Middleborough.
Eddy, Robert L.	West Brattleboro, Vt.
Flagg, Nolan R.	Grafton Square.
Fyfe, James G.	Worcester.
Giroux, Joseph E.	Somerville.
Godley, William M.	Boston.
Gregory, Joseph	Allston.
Griffin, Carl R.	Roxbury.
Hammond, Theodore	South Hanson.
Hastings, Clifton E.	Springfield, Vt.
Horton, Clifford	Hadley.
Hoyt, Willis H.	Walpole.
Jakobsen, Bernard	Roxbury.
Jones, S. Orville	Waltham.
Kalashian, M. Sam	Worcester.
Kelly, Shaun	Richmond.
Kern, Edwin	Middleborough.
Lindblad, Herbert V.	Barre.
Lorusso, Albert	Worcester.
MacCollom, Donald B.	Brookline.
MacDonald, Walter	Ayer.
Markert, R. H.	Amherst.
Master, Melvin	Lowell.
Maynard, Kenyon C.	Worcester.
McGlinchey, Frank T.	Waltham.
McKemmie, John E.	Amherst.
McNeil, Marie E.	Boston.
Nicholls, Reginald D.	East Fairfield, Vt.
O'Dowd, James	Quincy.
Outhuse, Donald	Littleton.
Owen, Edna	Goshen.
Paquin, Dr. L. A.	Webster.
Parker, Mrs. Charles W.	East Orleans.
Phelps, Henry	Dudley.
Phillips, Percy E.	Winchendon.
Prentiss, Russell I.	Lexington.
Proctor, Russell A.	Plymouth.
Putnam, Howard A.	Springfield.
Quirk, John F.	Brockton.
Reed, Frank H., Jr.	Greenfield.
Reynolds, Helen C.	Haverhill.
Ribero, G. F.	Franklin.
Robinson, Gordon N.	Lexington.
Rogers, John	Cambridge.
Rogers, Norman W.	Newtonville.
Rooney, Earl G.	Burlington, Vt.
Smith, Sidney A.	Worcester.
Snow, Thomas L.	Conway.
Stevens, Lenox	Portsmouth, N. H.

Sullivan, Daniel J.	Plymouth.
Taylor, Florence M.	Jamaica Plain.
Upton, Earl D.	Brockton.
Urquhart, Arthur E.	Danvers.
Wake, Edwin S.	Florence.
Wakefield, George M.	Lunenburg.
Wells, G. Allison	Springfield.
Wheeler, Frank A.	Springfield.
Wheeler, Hermon T.	Lexington.
Whiting, Rose S.	Berkshire.
Whittemore, Harry F.	Jamaica Plain.
Witherell, Stuart T.	Middlebury, Vt.
Young, Stanley P.	Wellesley Hills.

Summer School, 1925.

Acheson, Lillian	Fall River.
Adams, Margaret A.	Northampton.
Ahern, Mary A.	Boston.
Allbee, Rachel B.	East Hardwick, Vt.
Alvord, Alice W.	Easthampton.
Ansell, Harold K.	Grantwood, N. J.
Applin, Julia C.	Keene, N. H.
Armitage, Gordon	Smith's Ferry.
Barber, N. Violet	Warwick.
Barrows, Mrs. Robert	Amherst.
Bartholomew, Constance M.	Medford.
Bartlett, Esther	Amesbury.
Beeman, Marjorie	Ware.
Belyea, Beatrice A.	East Bridgewater.
Bennett, Florence	Mendon.
Benoit, Helen	Amherst.
Blanchard, Helen C.	Grafton.
Bogart, Nellie A.	Holyoke.
Bray, F. Roland	Amherst.
Brown, Mildred S.	North Amherst.
Bruorton, E. W.	Reading.
Buchanan, Walter	Methuen.
Burr, Anna	Sunderland.
Burt, Stanley L.	Brooklyn, N. Y.
Burton, John A.	Sharon.
Burton, Mrs. John A.	Sharon.
Cassidy, Morton H.	Amherst.
Chamberlain, Annette	Salem.
Chapman, Mrs. Bessie B.	Swampscott.
Chapman, Gean M.	Bradford.
Chenoweth, Winifred	North Amherst.
Clifford, Catharine F.	Dorchester.
Connelly, Helen M.	Dorchester.
Cook, Mrs. J. O.	Amherst.
Courtney, Mary C.	Holyoke.
Coveney, John	Amherst.
Cowdre, G. Willis	Holyoke.
Cowing, W. A.	West Springfield.
Dana, Minnie L.	Easthampton.
Denghausen, Alfred F.	Boston.
Despres, Mary L.	Lawrence.
De Vito, Dominick	Roxbury.
Dowling, Edith M.	Holyoke.
Dowling, Kathryn	Holyoke.
Dunphy, Anne T.	Haydenville.
Everson, Bettina L.	Amherst.
Fairman, C. Bruce	Amherst.
Fairman, Myrtle B.	Amherst.
Fay, Ula F.	Greenfield.
Fenton, Alice E.	Holyoke.
Fletcher, Doris M.	Springfield.
Foley, Gertrude A.	Ashmont.
Forte, Frances	Brighton.
Frost, Eleanor	Amherst.
Galanie, D. L.	Natick.
Gallagher, Frances I.	Charlestown.
Garvey, James J.	Holyoke.
Gates, Anna B.	Amherst.
Geiger, M. Emilie	Pepperell.
Gere, Laura B.	Springfield.
Ginsburg, Eli	Amherst.
Glavin, John G.	Shelburne Falls.
Goldberg, Louis N.	Wilmington.
Hackett, Olive E.	South Weymouth.
Harris, Anne L.	Somerville.
Hays, Mrs. Frank A.	Amherst.
Hebard, William E.	Chester.
Herrick, Edith L.	East Bridgewater.
Hintze, Marjorie A.	Amherst.
Hintze, Roger F.	Amherst.
Howard, Martin S.	Northfield, Vt.
Joy, Leroy A.	Whitman.
Julian, Mrs. A. N.	Amherst.
Kelly, Leslie M.	Amherst.

Keyes, Dorothy I.	Amherst.
Kidger, Marion P.	Newtonville.
Knightly, Anna	Amherst.
Krol, Helen C.	Bondsville.
Lambert, John F.	Gleasondale.
Lavery, Elizabeth R.	Orient Heights.
Lawley, Evelyn G.	Florence.
Lawrence, Earline	South Hadley.
Ludwig, Hilda J.	Waverley.
Lynch, Mrs. Sarah M.	Easthampton.
Madden, Archie H.	Amherst.
Mahoney, W. F.	Millville.
Marean, Josephine	Dalton.
Marean, Mina	Dalton.
Marshall, Maud A.	Amherst.
Mart, Willis	Amherst.
Martin, Mrs. Bertha W.	Amherst.
Martin, Edward W.	Amherst.
Martin, Margaret A.	Amherst.
Martin, Ural V.	Amherst.
Mayo, W. I., Jr.	Florence.
McCarthy, Mary E.	Florence.
McDonnell, Anna H.	Florence.
McFall, Mrs. Marjorie C.	Amherst.
McGee, Joseph A.	Natick.
McGeoch, Charles R.	Amherst.
McGlenen, E. W., Jr.	Boston.
McQueston, Helen B.	Hadley.
Merrill, Susan T.	Northampton.
Miltimore, John E.	West Springfield.
Mitten, Elizabeth M.	Amherst.
Moore, Marion J.	Orange.
Moran, John	Amherst.
Morland, Harold L.	Islington.
Morse, Ellen H.	Amherst.
Moynihan, Cornelius G.	Belchertown.
Newcomb, Roxie A.	Deerfield.
Nolan, Katherine M.	Dorchester.
Nolan, Mary F.	Dorchester.
Norcross, Roy E.	Brimfield.
Novick, Leo A.	Amherst.
O'Brien, Mary A. I.	Dorchester.
O'Connor, Deborah	Chicopee.
O'Connor, Eileen	Chicopee.
O'Connor, Margaret A.	Northampton.
O'Donnell, Marguerite	Lawrence.
Oliver, Charles F., Jr.	Brockton.
Olympio, Alerico	Lome, Togoland, W. C. Africa.
Osmun, Kenneth L.	Amherst.
Pariseau, Wilfred	Amherst.
Pearson, Vera	Holyoke.
Pendleton, Mrs. H. L.	Amherst.
Pierpont, Mildred	Amherst.
Powers, Mrs. Edna M.	Amherst.
Prescott, Glenn C.	Florence.
Pullen, Josephine	Beverly.
Pulley, Marion G.	Amherst.
Pushee, George F.	North Amherst.
Quinlan, James E., Jr.	Amherst.
Ray, Isabella J.	Lexington.
Readio, Marian A.	Florence.
Richardson, Lewis E.	Millis.
Roberts, Mrs. Ruth G.	Amherst.
Robertson, Mrs. Helen C.	Lawrence.
Rudquist, Birger J.	Dorchester.
Ryan, Parker	Swampscott.
Searle, Jean N.	Amherst.
Shea, Walter	Springfield.
Smith, Helen R.	Brighton.
Spencer, Mrs. Nellie	Amherst.
Stanisiewski, Peter	Amherst.
Stasz, Amelia	Easthampton.
Steinhope, A. W.	Greenfield.
Stiles, Marjorie	Westfield.
Sullivan, Julia	Dorchester.
Sullivan, Margaret A.	Amherst.
Sullivan, Mary G.	Roslindale.
Sweetland, A. F.	Stoneham.
Tetreault, A. J.	New Bedford.
Thomas, Howard	Holyoke.
Thompson, Lulu B.	Amherst.
Thompson, Nellie L.	Amherst.
Tierney, Winnifred	Springfield.
Towne, Mary E.	Amherst.
Twomey, Katherine A.	Lawrence.
Walker, Eileen	Florence.
Walsh, Mrs. Elizabeth	Amherst.
Watts, Mrs. Edna K.	Amherst.
Weaver, Edward	Amherst.

Weston, Evelyn E.	South Westport.
White, Lawrence H.	Amherst.
Wight, Elizabeth L.	Fiskdale.
Witt, Earl M.	Belchertown.
Wood, Celia M.	Springfield.
Wright, Ethel M.	Springfield.
Wright, Lela E.	Ludlow.
Yoffa, Eleanor	Gardner.

Students registered after the Catalogue for 1924–25 was published.

Vocational Poultry Course.

McLuskey, John	Holyoke.
Perkins, Harold Kent	Melrose Highlands.
Williams, Richard Harvey	Hudson.
Zunino, Ernest Joseph	Dorchester.

Summary of Short Course Enrollment.

	Men.	Women.	Total.
Two-year Course, second year	75	9	84
Two-year Course, first year	93	12	105
Vocational Poultry Course	3	–	3
Winter School, 1925	76	10	86
Summer School, 1925	58	113	171
Totals	305	144	449

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THE M. A. C. BULLETIN
AMHERST, MASSACHUSETTS

VOLUME XIX FEBRUARY, 1927 NUMBER 2

PUBLISHED EIGHT TIMES A YEAR BY THE MASSACHUSETTS AGRICULTURAL COLLEGE: JAN., FEB., MARCH, MAY, JUNE, SEPT., OCT., NOV. ENTERED AT THE POST OFFICE, AMHERST, MASS., AS SECOND CLASS MATTER

THE SIXTY-FOURTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

Issued in Accordance with Section 8, Chapter 75, of the General Laws

PART I.—THE REPORT OF THE PRESIDENT AND OTHER OFFICERS OF ADMINISTRATION FOR THE FISCAL YEAR ENDED NOV. 30, 1926

DEPARTMENT OF EDUCATION
THE COMMONWEALTH OF MASSACHUSETTS

LICATION OF THIS DOCUMENT APPROVED BY THE COMMISSION ON ADMINISTRATION AND FINANCE
3000 3-'27. Order 8534.

CONTENTS

MASSACHUSETTS AGRICULTURAL COLLEGE

REPORT OF THE PRESIDENT TO THE BOARD OF TRUSTEES, 19

I am sure that you will allow me to begin my first annual report to you as President of the Massachusetts Agricultural College with a s- cere word of appreciation for the confidence you have revealed in me by election to this important office. May I earnestly trust that in some measure your faith may be justified? I hope I have wisdom enough to know that I cannot fulfill every expectation. There will be mis- takes. My one hope is that I may be able to keep the error column down to a reasonable figure and the other record of good playing at so high a level as will rank me at least as a fairly satisfactory player. Whether that be possible or not, I assure you that I plan to give my best always to the institution over which you have done me the great honor to ask me to preside.

Centralized Control

A year ago at this time, I was obliged to call your attention to the centralized control established by the Legislature as it was working in relation to the administration of the college. This year I am glad to report a change in conditions that has relieved and eased the situ- ation greatly. It has progressed sufficiently to warrant the confidence that we shall in time reach reasonable and workable agreements upon every essential matter. I am happy to make this statement; and I should like to record my personal appreciation of the part that the Commission, especially the Chairman, has taken in furthering the reasonable rulings that now obtain on several matters that had hereto- fore bothered us. The situation is all the more gratifying inasmuch as efforts at legislation often result in feelings that sometimes linger long. So far as I am aware, there is no evidence anywhere of any feel- ing whatever between those who supported and those who opposed the legislative bill of last year.

Morale of the Faculty

The morale of the college staff at the present time is, I think, fair normal. It has improved measurably during this past year. Nothi

fects the spirit of a group like a condition of uncertainty. For six
ears, we had worked more or less in that kind of atmosphere. It was
ten a wonder to me how the faculty could maintain its *esprit de corps*
so high a level. At least, we have reached the point where we can
ope for a return to the high standards which must dominate a pro-
ssional group like ours if it is to render the effective service ex-
cted of it by those in authority and by the people it serves.

A Period of Readjustment

A good faculty morale is quite necessary, too, if we are to meet effec-
vely the problems and readjustments that are immediately calling for
ttlement. They are many and some of them involve delicate and diffi-
lt questions of internal organization effecting every member of the
aff. For ten years, we have been practically at a standstill so far
developing a constructive program is concerned. It has been dis-
nctly a transition period in the history of every agricultural college.
17 saw the apex of a long boom period in agriculture and the high
ater mark of student registration in the agricultural colleges. That
ar we had an enrollment of 680 students, all candidates for the de-
ee. Then came the war; the agricultural depression; a reduced
gistration in agricultural courses here and everywhere; and appro-
iations based on a policy of strict economy. Besides these factors,
ere were also for us the new adjustments to centralized control in
oston. It was natural to wait for the tide to turn and to postpone the
nsideration of a constructive program until more definite and satis-
ctory conditions prevailed. The significance of this transition may
suggested by the fact that of the 700 (approximately) students on
e campus today, 115 are girls, 425 are boys in the college course,
d 160 students in the two-year short course; as against 680 boys in
17 in a uniform collegiate course. This one fact alone shows the
pe of problem that presents itself to the officers and faculty for early
d constructive solution.

Fundamental Problems

Our obvious duty is to move as rapidly as possible upon the one or
o important fundamental problems. As I see it, the imperative one
the revision of the four-year course of study. The course as it now
nds has been in operation, with some modifications, since 1910. Ever
ce the war, President Butterfield had often expressed the desire to
rk out a revision but for one good reason or another he did not ac-
nplish it. As Acting President, I did not deem it wise to consider it
view of the appointment of a permanent executive. At last, we have
en it up. The course of study committee of the faculty has been
eting regularly for some time past. I hope to have it continue its
rk until a course of study results, better fitted to our needs and con-
ions than the present one. If this problem can be worked out in a
rly satisfactory manner, and I have faith that it can, many other
blems will be solved at the same time.

Anyone who has been connected with a curriculum problem of this
d, knows that it is an extremely difficult task at any time anywhere.
an institution so complex as ours, the difficulty is aggravated by the
ny different points of view held, the many departments intimately
olved, a schedule which always has to consider a great many lab-
tory arrangements, and by the large number of different objectives
t the students desire to have us meet. While the need for a modi-
tion is most pressing, nevertheless, I feel that we should move
wly and deliberately enough to work out a curriculum as satisfac-
y as possible to all the factors involved. The main consideration,
vever, should be the welfare of the student. Everything must bend

to the aim of giving him the best training possible. I am quite hopeful of the outcome and believe that it can be worked out sooner than some of us anticipate. It should go into effect, in part at least, by the opening of the next college year.

The difficulty of this problem may the better be appreciated by calling attention to some of its implications. In 1923 an Alumni committee made an exhaustive study and filed a report on the curriculum. Later a committee of farmers' organizations did the same thing. The findings of these groups will have to be considered. Then there is the fact that one-fifth of the students are girls. We have been asked by the New England Council to train market experts as soon as possible. Such questions as the following will have to be answered: We have seventeen major groups at the present time; if we combine them how shall we do it? Which shall be combined: Shall the freshman year be required as now or shall it have options? If options, how many? Shall elections begin in the sophomore year as now or shall they be deferred until the junior year? Many of these questions are such as to allow a difference of opinion and therefore likely to provoke much discussion.

Professional Improvement

There are other important problems that intimately touch the faculty which will have to be solved with their co-operation. One of these is: What plan of professional improvement can be devised to meet most effectively our needs and situation. This will apply not only to the resident teaching staff but to the extension and especially to the experiment station group as well. If we are to meet the competition of other colleges, we must soon establish some reasonable plan along this line. Just now a sabbatical year, even for the teaching group, seems remote. We have tried to meet the demand of individuals by an occasional travel privilege on a 50-50 basis, also by allowing certain individuals to take courses in the college along the line of their work and interest. Another question is: Shall there be a distinction in salary made between the eleven months and the ten or nine months member of the staff? If so, what shall it be and on what grounds shall it be made? Some of our sister colleges have started to differentiate between certain types of service, and partly on the basis of the difference in the amount of time of service between the members of the three groups that make up the agricultural college organization.

Before dismissing faculty and curriculum matters, your attention should be called to another important item connected with both: namely, that the major elections of students in our agricultural colleges reveal a rapid and constantly shifting change of emphasis. Sometimes a major will be elected heavily for a number of years; then, without warning, a shift takes place and another major becomes prominent. This sudden change is most disturbing to the individual departmental administration which usually is organized carefully to meet the needs of a definite number of students. Whether any curriculum arrangement can be devised that will meet such fluctuations is doubtful. The main motive affecting the choice of the student is, I am sure, the immediate economic advantage that the major promises. The major that opens the door immediately to a good job, as the boy would put it, has "the call." The same motive also accounts for the smaller registrations prevailing in the agricultural colleges at the present time. It will continue to operate thus until the prospective student or freshman sees clearly that there is as good a wage or income opportunity in agriculture as there is in some other vocation that he may enter. Common comment of executives in Washington last November was "when agriculture looks up as it did in 1916, the students will come back in equally large numbers."

To illustrate this point the following figures will probably serve.

he first four major choices of the classes of 1922-1925 inclusive in the :der of preference were as follows:

1922	An.Hus.	17	Ag.Ec.	15	Chem.	13	Pom.	11
1923	Pom.	20	Ag.Ec.	17	An.Hus.	12	Land.Gard.	11
1924	Ag.Ec.	16	Pom.	15	An.Hus.	9	Land.Gard.	9
1925	Ag.Ed.	17	Ent.	13	Land.Gard.	12	An.Hus.	11

Here are four different firsts in four successive years. Animal Husındry goes from first to fourth place, and Agricultural Economics 'ter holding a relatively high place for three years, goes out alto-ether in the fourth year. The whole shift is explained by saying that e students thought the dairy game offered the best chance in 1922, e apple game in 1923, marketing in 1924, and teaching in 1925.

Facilities for Women Students

Another urgent problem is that connected with the housing of women. ıst year the girls' dormitory was filled and the social facilities of the llege were taxed to the limit. In view of the many applications ming in we were faced last spring with the question, "what shall e do with all these girls if they present themselves in September?" was evident that we should need additional room. A careful survey the town revealed that very little relief could be obtained there. The ssibility of renting a large house or two was entertained for a while ıt was abandoned in view of the cost of heating, service (janitor and atron), and the high rental. Finally, we decided to limit the num-rs on some fair and sensible basis, and to utilize only the accommo-tions available on the campus. The rooms occupied by the office erks in the dining-hall were taken over. These would take care of out fifteen. It meant that the clerks, many of whom had occupied ese quarters for years, would have to seek accommodations off cam-ıs. It also meant the additional cost of employing a matron. The an was carried out to the point of notifying the clerks that they must cate, and of asking Miss Diether, manager of the dining-hall, to act matron along with her other duties. In August, we were informed the Dean that many of the applicants were withdrawing. It became ident that we would not need the dining-hall quarters after all. Most the clerks came back. It is needless to say that the experience for em was not a happy one. The cause for the large number of with-awals is partly explained by the fact that some of the applicants had arly planned to enter other colleges; ours was a second or third oice.

The girls' dormitory was planned with the single purpose of housing many girls as possible. On this account, no dining-room was in-ıded in the plans, and the reception or living-room was reduced to ıat we now know to be inadequate dimensions. In order to meet this uation more effectively another year, Miss Skinner advised that some the rooms on the lower floor of Abigail Adams Hall be taken over. re-arrangement they could be made to meet our present needs fairly ll. We should like to have been able to do this, but, on account of cost and the urgent need for living rooms, we could not see our y. It is quite clear that we shall have to provide more room for :ial purposes in the very near future.

[have said enough to indicate the significance and implications of adoption of a policy that will increase the number of girls at the lege. It will probably cost some money, and it is sure to result in oblems that hitherto we have not had to face. Much, therefore, de-ıds upon the policy to be established by the Board of Trustees. The ole question is involved necessarily in the larger question of the pe of the college now under consideration by the sub-committee. ere is no doubt that the offerings of the college now present most ractive educational and vocational opportunities for women.

The problem of properly housing the women students suggests t old question of properly housing the men. A dormitory of good pr portions would be a great boon. It would relieve a congestion that h been with us for a long time. Besides, our type of boy would pro greatly by the social contacts which the life of a dormitory affor If a new dormitory were maintained as a freshman dormitory, eve student in college would have the experience of a year of close conta with members of his class. The result would be, I believe, most ben ficial and far-reaching, not only upon the life of the individual stude but upon the family feeling of the whole student group. I believe t Trustees are right in constantly stressing this building project as o of prime necessity.

Building and Equipment Needs

Our building equipment on the whole is excellent. The great ar of the campus with its many buildings, always looks adequate a complete to the visitor. We who "carry on" with the students, year and year out, however, are conscious of a number of serious deficienc still if the students are to receive the best service that a good colle equipment should afford. In order to "round out" our building equ ment, we need two or three major buildings and several importa minor items. What these should be, I have tried to show in the l below. It was prepared tentatively in quick response to the requ of the Commission on Administration and Finance last summer to ha us indicate our desires regarding a five-year building program. It w approved in September by the full Board as it stands below:

1. Men's Dormitory ($150,000) or Women's Dormitory	$250,0
2. Gymnasium	350,0
3. Administration & Recitation Building	100,0
4. Physics Bldg. (Completion of Microbiology Lab.)	150,0
5 Enlargement of Clark Hall	65,0
6. Horticultural Manufactures Bldg. & Equip	60,0
7. Roads and Walks	30,0
8. Enlarging College Reservoir	25,0
9. Practice house—Home Economics	21,0
10. Women's Gymnasium and Equipment	16,4
11. Better Fire Protection	50,0
12. House for the Chief Engineer	7,5
13. New Steam Line, East Exp. Stat. to Micro. Bldg.	4,7
14. Repairs on the Old Durfee Greenhouse	7,0
15. Making over Fourth Floor of North College	4,0
16. Culvert for Brook in Ravine	2,6
17. Additional Land, Cranberry Sta., East Wareham	1,0
18. Repairs on the Harlow House	1,0
19. Library Building—important but tentative	100,0
	$1,245,3

How many of these items will be included in the recommendatio of the Commission on Administration and Finance (for a five-year sta building program) no one knows. What we do know is that the sta faces tremendous demands for building construction at this time. Wi other departments we are caught in a rather helpless situation an therefore, may find it exceedingly difficult to get the building appr priations which we so much need. There are many items in the abo list that we ought to have immediately if we are going to do the mo effective work and to render the best educational service to the st dents.

Private Gifts

If the demands of the state situation result in further postponeme or us on some of our projects, I see no other way out than to seek for unds from private sources. There is no good reason why this should ıot be done in any case. Ours is one of the very few state educational nstitutions that has yet to receive the gift of a building from a private lonor. Some of our sister colleges and universities have as many uildings erected by private as they have by public benefactions. I annot believe that an institution that has rendered such conspicuous cientific and educational service in the agricultural field cannot appeal vith persuasiveness and power to the friends of agriculture, as well s to men of wealth favorably disposed to promote worthy projects. Has not the time come for us to consider seriously a campaign in behalf f this institution that will bring her claims to the attention of public pirited and philanthropic men? I am inclined to think that it has, nd I hope that the Trustees will agree with me sufficiently to take up t an early date the question of promoting effective machinery for such n appeal.

Let me record here what I have often emphasized,—namely, that the aising of the funds for the Memorial Building and the carrying hrough of that splendid project was a great accomplishment, especially n view of the number and resources of our small body of alumni. It ives us cause for real pride whenever we think of it. I am sure that ve can expect from the Alumni a similar response to other needs as hey arise, but they alone are not capable of doing the things that we eed to have done. We must appeal to other friends as well. Can we ot make a concerted effort to reach those who do not know the record f this institution, or appreciate the great possibilities for effective pub- c service that resides on the campus?

It is a great pleasure here to report recent gifts that point to an in- reasing appreciation of our need for supplementary funds. They lend ope to the success of an appeal such as I have mentioned. I refer o the gift just received of $23,000 by the will of the late Porter L. New- on of Waltham; the gift of $5,000 from our late colleague and friend, Ion. Charles A. Gleason of North Brookfield; and a gift last month f $5,000 from the late Rear-Admiral George H. Barber, an alumnus of ie college. There is also the possibility of a fund from the Lotta Crab- ree Estate. These recent additions increase our trust funds of last ear from a total of $85,000 to close to $120,000. These, in the main, re gifts to provide loans and scholarships to worthy students. We an use a great deal more for the same purpose. I hope to see the total oubled within the next year or two. There is no doubt that we have great many other friends who will be glad to help the worthy boy nd girl that we are trying to serve if they are only fully acquainted ith our needs and demands.

Memorial Hall

The usefulness of Memorial Hall as a student center has grown stead- y. It supplies excellent facilities for the growing student academic ctivities, the lounge is increasingly used for study and reading by udents who room a considerable distance from the campus, almost ie whole social life of the campus now centers in this beautiful build- ig. The alumni gave the State much more than $150,000 when they ade that gift; they gave to the boys and girls of Massachusetts for enerations, a place of meeting which is bound to result in wholesome ssociations and friendships as well as inspiring memories.

Resignations

A number of particularly significant resignations have occurred dur- g the year. The resignation of Mr. Ralph J. Watts as Secretary of ie College, after a long and effective service of eighteen years, rep- esented a distinct loss to the institution. Mr. Watts knew the alumni as a whole better than any other person on the campus. During th time he was with us, he had made many contacts and had accumulate a store of information that was invaluable to the executive. His re tentive mind could reach back for almost anything that had happene during his term of office. He was always more than a secretary. H knew the business of the college second only to the Treasurer, and th call to an important business managership was the logical result of h great interest and ability. He gave a whole-hearted and devoted ser ice to M. A. C. that will be long remembered.

Mr. Robert D. Hawley, M.A.C. 1918, Extension Editor, was appointe to fill Mr. Watt's place.

Equally significant was the resignation of Mr. John D. Willard, dire tor of the Extension Service, after six years of most able and efficie service in this important administrative office. Director Willard's lea ership has been fruitful of sound development in all phases of the wor His insistence that extension teachers should guide agricultural d velopment along sound economic lines has had a wholesome and fa reaching influence. He made distinct progress in co-ordinating th various agencies of agricultural extension service and guided the d velopment of a home economics service for Massachusetts women s that it is outstanding in the nation.

Mr. Willard A. Munson, M.A.C. 1905, formerly Director of the Burea of Markets of the Massachusetts Department of Agriculture, was a pointed to succeed Mr. Willard.

The positions formerly filled by Professor Henry F. Judkins, Hea of the Department of Dairying, and by Professor Schuyler M. Sali bury, Head of the Department of Animal Husbandry were combine last spring and Professor J. H. Frandsen was appointed to the larg position. He comes well qualified. He has been Head of the Dairy D partments of the University of Idaho and of the University of N braska, has served as an editor of the Capper Farm Press, and is edit of the Journal of Dairy Science which is the official organ of the Amer can Dairy Science Association.

In Memoriam

It is my sad duty to report the death of two members of the staff ar our former beloved colleague and friend, Professor Charles E. Wellin ton. On September 28, the whole community was shocked and grieve by the accidental death of Miss Bertha Knight, Extension Speciali in Home Economics, who was killed in an automobile accident at We Barnstable, Mass., while on active duty for the college. Miss Knigh was liked by all who knew her, capable in her work, and her loss keenly felt, not only at the college but throughout the state where he good work had already made for her many friends.

On August 19, Miss Helena T. Goessmann died after an extende illness. She was the daughter of Professor Charles A. Goessmann, th distinguished and beloved chemist whose name is so closely identifie with the scientific reputation of the college. She had served the co lege effectively as instructor in English for fifteen years. Miss Goess mann was a stimulating and interesting teacher and had a host o friends among the members of many classes.

Professor Charles Wellington, Ph.D.

Professor Charles Wellington, whose death occurred on Novembe 15th, after a long period of illness, served the college for thirty-eigh years (1885-1923), first as associate professor of chemistry, later a head of the department and professor of chemistry. He was not onl a thorough student in his chosen profession but an excellent linguis and a wide and thoughtful reader in history, philosophy and belles lettres. Completely devoted to his Alma Mater, he worked incessantl or its upbuilding. Not only did he give unsparingly of his time but lso gave generously of his own slender stipend. He was always inerested in student activities and endeavored always to awaken in stuents the highest ideals of life. Modest and unassuming in his daily ife, Professor Wellington was possessed of a refined, Christian charcter and his life motto was service. Those who knew him best loved im most and in his passing the college has lost an ardent supporter vhile his friends and associates are conscious of a loss in many ways rreparable.

Classification of Personnel

The Legislature at its last session ordered that a study be made of he classification of personnel in the employ of the Commonwealth, and hat report be made at the next session. Accordingly, a private agency vas employed and the study conducted during the summer of 1926. ll employees of the college were, of course, included in this study and he recommendations of this agency will involve every one. The basis f the study was a questionnaire answered by each employee. Departnent Heads were given hearings and opportunity to make recommenations. By your authority, as you will remember, I recommended to ne classification survey staff the following salary limits for our proessional staff:

nstructors $2100 from $1900 (approximately)
sst. Professors $3300 from $2900 (approximately)
'rofessors $4200 from $3900 (approximately)
[eads of Administrative departments $4500 to $5000 from $4200 to $4500 (approximately)

My suggestions were given sympathetic consideration at the hearing ut we shall not know what the outcome will be until the legislature cts.

Report of Student Committee on Curriculum

In an effort to discover the point of view of the students and to get rom them suggestions for our curriculum, I appointed, last spring, a ommittee of seven representative seniors and asked them to give careil consideration to the subject with a view to report to me their findigs. This committee did a very commendable piece of work indeed i the short time allotted to it. In the report I find the following inresting suggestion:

"Our other primary suggestion is the transmission of an almost uniersal appeal for more English in the curriculum, not only as elective ourses, but as required courses. English Composition and Public peaking were strongly desired and recommended to us as absolutely ssential. As seniors, the men encountered felt almost universally iat they would have appreciated being required to take more English ian they did.

"It is hardly necessary to argue the case for English before an eduated group of readers. The above expression is simply an indication iat it is now felt that the standard of English obtained by college raduates is not high enough. Just how much more English should e required and the kind of English to be insisted upon was a matter f considerable discussion. However, from the wealth of discussion, e feel that we are expressing the sentiment of the students, especially ie seniors who now realize their mistake in not taking more of it, hen we recommend that four courses of English be required during ie junior and senior years, to be taken at the individual's will with ie stipulation that at least one of them be a straight course in comosition."

I have asked another group of seniors this fall to continue the study begun by this committee. The combined report will, if thought d sirable, be published later.

Legislation

A significant piece of legislation was passed during this year whe the State Legislature passed an Act to define the authority of the Tru tees of the Massachusetts Agricultural College in administering tl affairs of the institution. The following is the act as passed:

"Be it enacted by the Senate and House of Representatives in Ge eral Court assembled and by the authority of the same, as follows:—

Section four of chapter fifteen of the General Laws is hereby amende by adding at the end thereof the following new sentence;—Nothin in this chapter shall be construed as affecting the powers and dutie of the trustees of the Massachusetts Agricultural College as set fort in chapter seventy-five,—so as to read as follows:—**Section 4.** Th Commissioner shall be the executive and administrative head of th department. He shall have charge of the administration and enforc ment of all laws, rules and regulations which it is the duty of the d partment to administer and enforce, and shall be chairman of th board. He shall organize in the department a division of public libra ries, a division of immigration and Americanization, a division of th blind and such other divisions as he may determine. Each divisio shall be in charge of a director and shall be under the general supe vision of the commissioner. Nothing in this chapter shall be construe as affecting the powers and duties of the trustees of the Massachusett Agricultural College as set forth in chapter 75."

This Act simply affirms the power of the Trustees and defines thei relationship to the Head of the Department of Education. The Com mission on Administration and Finance, still has authority over pu chases, salaries, and budget matters.

New Construction

The new construction for the year 1926 amounted to approximatel $30,200.00.

This included the replacement of the Cranberry Station building a Wareham, destroyed by fire May 30, 1926, at a cost of $9,000.00. Th new building is of concrete blocks and provides for an auditorium, laboratory, and office rooms. A three car garage was also built fron this appropriation.

A foreman's cottage was built at the Tillson Farm which provide five rooms and a bath for the foreman of the Experimental Poultry Farn with two offices and a laboratory room for the scientific work.

The Physics building was repaired at a cost of $4,000.00. This pro vided for a cement floor in the basement, steel ceilings, new cases fo the apparatus and re-wiring with new lighting fixtures and painting throughout.

New calf and quarantine barns were built next to the young stock barn to provide for the development of a herd free from contagious abortion. The calf barn takes care of 45 head, the calves being held in isolation here until they react negatively to the blood test. The quarantine barn contains 6 stalls. These two buildings are models of their kind. The cost was $11,200.00.

HIGH SCHOOL DAY

The 17th Annual High School Day was held at the College Satur- day, May 1st. This event, which has been held regularly on the first Saturday in May, was first started in 1908. It has been attracting an increasing number of high school boys and girls from a greater num- ber of schools each year. This year there was a record attendance of

4 boys; 185 girls; 73 teachers, principals, town representatives and hers; and probably 100 more visitors who failed to register. These sitors represented 108 different schools throughout the State.

It has always been the purpose of High School Day to provide an portunity for those interested to inspect the College in its entirety, meet the undergraduates and learn of their activities, to interview e faculty relative to the work of the college, and to gain an insight to the exceptional vocational advantages offered in the field of agri- lture and allied sciences. A large number of the boys and girls me as guests of friends already in college, while alumni, teachers d town representatives organize groups which come by various means om all parts of the State.

The program for the day has been improved from time to time until e which we believe to be of interest to the greatest number has been veloped. This year a live stock parade was added to the program d because of the significance of the live stock judging contest it was lled the Massachusetts Interscholastic Live Stock Judging Contest. ie three leading contestants from vocational schools were selected represent Massachusetts in the Vocational Judging Contest at the ational Dairy Show held at Detroit in October. One of these boys, ic Moberg of Smith's School, Northampton, Mass., won a $400.00 holarship to use at the college of his choice.

The poultry and fruit judging contests are proving equally as pop- ar and interesting. The detailed program and analysis of attendance r 1926 follows:

Program for the day

:00 A.M.—Registration booths open.
:15 A.M.—Poultry Judging Contest.
:30 A.M.—Exhibition by the Cavalry Unit.
:00 A.M.—Inspection of the campus and college buildings.
:30 A.M.—1:30 P.M.—Explanation of entrance requirements.
Live Stock Parade.
:00 M. —Luncheon—Draper Hall cafeteria open from 12:00 to 1:30.
:30 P.M.—Luncheon meeting of teachers, principals, school superintendents, and Town Representatives.
:00 P.M.—Inspection of the Campus.
:00 P.M.—Varsity baseball game—M.A.C. vs. Wesleyan.
:30 P.M.—Supper—Draper Hall cafeteria open from 5:30 to 7:00.
:00 P.M.—Address by Acting President Lewis.
Award of prizes for interscholastic championship live stock, poultry, and fruit judging contests.
Musical Clubs concert and Roister Doister play.
:30 P.M.—Fraternity receptions.

Registration

	1926	(1925)
ys	460	(411)
rls	185	(153)
achers and others	73	(72)
Total	718	(636)

	1926	(1925)
umber of schools represented	105	(90)

Judging Contests

	No. of Teams		No. of Individua	
	1926	(1925)	1926	(192
Fruit Judging	13	(4)	44	(1
Poultry Judging	18*	(13)	58	(4
Live Stock Judging	26**	(21)	78	(6
	57	(38)	180	(13

* 4 individuals entered in addition to 18 teams.
** 15 senior teams.
11 junior teams.

Infirmary

During the year beginning September 1, 1925 and ending Septemb 1, 1926 one hundred and thirty-two house patients were treated at t infirmary for various lengths of time amounting in all to five hundr and ninety-six hospital days. In addition to this number, two hundr and fifty-seven out-patients made four hundred and fifty-nine visits the infirmary for treatment and advice.

The outstanding diseases of the year were:

Appendicitis	6
Bronchitis	2
Coryza	4
Diphtheria	2
Heart Disease	1
Infections	8
Influenza	47
Measles	1
Nephritis, acute	1
Neuralgia	1
Pleurisy	1
Pneumonia	5
Sciatica	1
Sprains	8
Tonsillitis and throat troubles	17
Miscellaneous	10
Surgical, minor	16

Diphtheria broke out in one of the dormitories but was quick stamped out by preventive treatment. An outbreak of influenza o curred involving a large number of students. The disease was n severe and it ran its course in a very few days. On the whole tl health of the college students has been excellent. This satisfactor condition is in large part due to the splendid co-operation of the st dent body, to the watchfulness and care of Professor Hicks and Miss Christopher, the resident nurse, and to the attention of Mr Macrae, the matron of the infirmary.

In closing this first report, let me say that you have handed over my direction an institution which has served the Commonwealth fait fully and effectively for sixty years. It represents the labor and sacr fices of many eminent educators and devoted faculties. It can be sa to have educated not only skilled workers and good citizens, but son of the most influential leaders in agriculture in state and nation. I Alumni cherish it with a devotion which I know from experience, deep and abiding. In the presence of its record and achievement, feel both grateful and humble.

It is a great public service institution. Its Extension Departme today reaches to all the corners of the state. Its Experiment Static staff is working quietly on scientific problems that will vitally affe not only the farmer and the farmer's business, but every business i he state. Its resident teaching staff is not only giving freely to agriculure and industry the benefits of the soundest theory and practice that ; knows, but it is also striving to give its students the best education ossible both for life and for living.

My hope is that I may so direct its affairs that it will not lose a jot f its present strength and power. I want it to continue to be a dyamic public service institution. I want it to increase in influence and restige not only because of what it does but because of what it is. I ant it never to fail to serve the great cause of agriculture to the limit. want it useful and efficient in every service it renders. I want the xtension Department to reach people more and more, the Experiment tation to ascertain some of the facts upon which New England proserity should build, if it is to develop and thrive as it ought; and I want he college to give the boys and girls of the Commonwealth a larger nd broader outlook on life as well as skill and ability in their chosen rofessions. I want it to continue to be a college of excellent rank, orking at full speed up to its full capacity all the time, and I shall lways strive to keep it so. All this I want; not only because the state ays for it in cold hard cash, though that is reason enough; but beause the state needs it and needs it greatly both today and tomorrow.

EDWARD MORGAN LEWIS,
President.

LEGISLATIVE BUDGET 1927

Projects for Permanent Improvements

1. DORMITORY, $150,000.

For many years the Trustees have had before them the problem of roviding adequate housing facilities for the resident students of the ollege. The demand for a dormitory has become increasingly pressing ach year. The capacity of private houses available for student rooms about taxed to the limit and prices charged students are somewhat igh as a result. For several years the request for a dormitory was ncluded in the budget. In recent years other projects have sometimes ppeared more immediately urgent and the item for a dormitory has herefore at such times, been omitted. The Trustees are again preenting as the project which in their judgment is most needed at present, an item of $150,000 for a dormitory. This can, if necessary, be ocated south of South College on an existing steam main and adjacent other service lines. It is proposed to build a dormitory that will ccommodate approximately 100 students. By charging a rental somehat less than that charged in private houses off the campus, it is stimated that a return of from 2% to 3% can be made to the State on his investment.

2. HORTICULTURAL MANUFACTURES BUILDING, $60,000.

The importance of utilizing various by-products of the farm which ormerly were wasted, such as fruit and vegetables, was emphasized uring the war, and under the direction of Prof. W. W. Chenoweth of his institution farmers came to see whereby this saving could to adantage be made permanent. In order to give adequate instruction in he preservation of fruit and vegetable products, a new laboratory uilding is essential. The plans provide for a one-story building of nexpensive construction, which will furnish laboratories for the varius phases of this work.

The pressing need for this building is now generally understood. owever, some of the principal considerations may be recapitulated as ollows:

a. The department of horticultural manufactures now has its work idely distributed in four buildings, viz. Flint Laboratory, Wilder

Hall, French Hall, and a workshop on the hill near the cold storae plant. This wide scattering of the work is obviously very detrimen l to its objective.

b. The principal teaching is done at Flint Laboratory in rooms whi were designed for use by the dairy department. The dairy depa- ment needs these rooms and would like to see the department of hor- cultural manufactures cared for elsewhere as soon as possible.

c. The present quarters are entirely inadequate for the teachi work. On account of the limited space the department has been co- pelled to refuse admission to numbers of students. This is perhaps t only department in the institution which has been compelled frequent to refuse admission to students on account of the lack of space. Al the teaching could be much better organized and more efficiently co- ducted in a new building designed for this particular work.

d. It is highly desirable that vigorous research work be undertak at the earliest opportunity in the field of fruit and vegetable preserv- tion and the manufacture of by-products. A strong demand exists f this work among fruit growers, but the subject is equally important all consumers of food in Massachusetts.

e. The department is now carrying on important extension work, b these extension projects need to be strongly supported by effecti work at the college, and especially by well-directed research work.

f. The Massachusetts Fruit Growers' Exchange Association, t Boston Market Gardeners' Association and other organizations ha urgently requested this proposed building. This demand from t fruit growers and vegetable growers should be squarely met.

3. Roads and Walks, $11,000.00

In order to provide improved roads for the main thoroughfares the campus and to institute permanent walks it is proposed to bui small sections of each from year to year. In 1927 it is desired to e tend the macadam road started in 1923, a distance of 1800 feet, fro the Library Building to the Power Plant. This section carries tl heaviest traffic which comes to the campus and the present dirt ro is entirely inadequate, especially during the seasons of frost and heavy rains.

The estimate of $10,000 is for a 5 inch crushed rock foundation wi a 3 inch bituminous bound surface. It is also proposed to build cement walk from South College to the Drill Hall, a distance of a proximately 600 feet, costing $1,000.00.

4. Women's Gymnasium and Equipment, $16,400.00

With the increased number of women students attending the Colleg the need of a woman's gymnasium becomes imperative. With the a propriation here requested it is proposed to erect a wooden fram building adjacent to the present Women's Dormitory. Placed in thi location it will be unnecessary to duplicate dressing rooms and showe baths. The amount requested will provide for the necessary equipme for the building.

5. Grading Area South of Athletic Field for Tennis Courts, $10,50(

In order to amplify the present inadequate facilities for outdoo games it is proposed to construct 10 tennis courts on the area immedi ately south of the present enclosed athletic field. The grading co templated is on the basis of the permanent future development of th enclosed area. The expense for grading, surfacing, fencing, etc. i $10,500.

6. New Steam Line, East Experiment Station to Microbiology Building, $5,000.00

This project contemplates replacing a section of underground pipe line which is now in poor condition. The new line would be 385 feet shorter than the present one, thus effecting greater economy in operation.

7. Gymnasium, $150,000.00

A gymnasium has for many years been considered as one of the most pressing needs of the institution. The present so-called Drill Hall offers no facilities whatever for gymnastic work or for other organized forms of physical education. The building is unsuitable even for the practice of basketball which is the only use to which the building is now put. The locker rooms and toilets adjoining the Drill Hall floor are extremely unsanitary and any improvement in their condition is practically impossible. It is proposed, therefore, with the appropriation here requested to begin the construction of a new building for physical education purposes along the lines of some of the buildings recently built at Dartmouth, Bowdoin, Amherst, etc., where they are using a large dirt floor cage owing to the rigorous winters we have. This would consist of two units—one containing dressing rooms, shower baths, swimming pool, boxing and wrestling room, office, supply room, a corrective gymnastic room, two class rooms, and then a connecting unit to this main gymnasium building where all the work ordinarily done out of doors in the Fall and Spring could be carried on throughout the winter.

8. Fire Truck, $2,500.00

The college fire protection is dependent on the equipment furnished by the Town of Amherst. When the present truck was purchased in 1915, this institution with Amherst College paid almost one half of the cost. This truck is about worn out and the town feels that a new one will have to be purchased very soon. The cost of a new, up-to-date machine would be $10,000 and it is suggested that this College and Amherst College pay one half the cost, our share being one fourth or an amount not to exceed $2,500.

9. Steam Heat at Poultry Plant, $2,400.00

It is proposed to heat the two laboratories with the exhaust steam from the Power Plant. Mr. Bovenzi estimates this work at $2,400.00.

10. Repairs to Durfee Range Glasshouses, $7,000.00

The old Durfee Range of glasshouses was built in 1870 and holds one of the finest collections of tropical plants in this section of New England. It is in very poor condition and should be completely overhauled. The rebuilding of these houses to save this valuable collection should be done within the next 12 months. This would mean a considerable outlay for new sills, studs, rafters, posts, ventilators, benches, etc. and also reglazing and repainting. This would cost about $7,000.00 but would mean the saving of a set of houses that could not be replaced at the present time for $20,000.00.

11. Culvert over Brook in Ravine, $3,000.00

In order to provide adequate storage for the large supply of coal which is being carried during the greater part of the year, it is necessary to construct a culvert over the brook in the ravine adjacent to the

Turbine House. The proposed culvert would be 200 ft. long, 4 ft. hig and 5 ft. wide and could be built at an estimated cost of $15.00 pe linear foot.

REPORT OF THE DEAN

The question may rightfully be raised whether the Dean at this col lege should carry any considerable amount of teaching. If he does, th combination is certain to be strenuous even under the most favorabl conditions. That he would be justified in devoting all his time an energy to work connected with the enlarged and ever enlarging scop of the Dean's Office needs no argument. And yet I feel that contact with students, which are almost invaluable to an administrator, ca be made only in the class room. Teaching also serves to break th somewhat monotonous routine work which has to be handled by an Dean. Again, to me personally, teaching is a real and inspiring stimu lus and I have accordingly continued my teaching work in the Depart ment of Mathematics. It is my hope to so organize the duties of th Dean's Office as to allow me to continue my work for the students i the double capacity of teacher and Dean.

During the two years prior to my appointment as Dean I held th double appointment of Acting Dean and Acting Registrar which gav me an excellent opportunity to study the close relation and interde pendence of the work of these offices. As a result a reorganization wa effected this year which merged the Registrar's Office with the Dean' Office. The Dean is in general charge of the newly organized uni Under him are (1) an Assistant Dean, M. O. Lanphear, whose chie duty is in connection with matters of entrance and registration; (2) a Assistant to the Dean, Grace E. Gallond, in immediate charge of th office, routine matters concerning absences, appointments, requisition in a sense the Dean's personal Secretary; (3) Clerk, Olive M. Turne who continues in charge of students records and as general assistan in entrance and registration routine; (4) a Stenographer, Emma Von dell, who also assists with Dean's and students' records.

All except Professor Lanphear have been in the office for a consider able number of years and are doing their work in a very commendabl way. Professor Lanphear is a graduate of the institution, a successfu teacher and a sympathetic friend of the students. He has already mad a creditable beginning in the new organization.

For the purpose of encouraging scholarship a system of Hono Groups was introduced at the opening of the fall term. This systen recognizes three groups of honor students. The first group include the names of all students, excepting Freshmen, whose term average fo all courses is above 90 per cent. The second group all those betwee 85 and 90 per cent, and the third group those between 80 and 85 pe cent.

These groups are posted on the Dean's Board at the beginning o each term. Students in the first two groups are allowed great freedo in the matter of class absences. The system is receiving much favor able comment from both faculty and students, and appears to act a a real stimulus for the improvement of scholarship. At the beginning of the first term the list posted contained the names of six students i Group I, thirty-seven in Group II, and forty in Group III.

The Honor Council has functioned satisfactorily and the limited num ber of cases referred to it were handled with justice and dispatch The nerve racking cases of excessive cutting and serious infringement of necessary regulations were very few indeed. The spirit of real co operative endeavor between the student body and those in authority on matters of institutional policy and practice was all that could be reasonably expected.

Much credit is due to the following who assisted the Dean as faculty dvisers to the new students:

.ss't. Dean M. O. Lanphear
'rofessors F. P. Rand, Paul Serex, A. N. Julian, Richard W. Smith, Miss Skinner, Miss Knowlton
ıstructors L. L. Durkee, Philip Couhig.

Their helpful counsel and sympathetic direction constitute a service 'hich is greatly appreciated by parents and students.

During the year I have accepted a number of invitations to speak to roups of high school and junior high school students throughout the :ate. These contacts are valuable in promoting cordial relations and etter acquaintance with the schools, and in the opportunity they afford f giving first hand information concerning matters of entrance and nes of work offered at the college.

As to immediate problems the following are noted without extended ›mment:

1. A definite plan for a more helpful "subjective analysis" of stu- ›nts through tests, achievements, personality ratings, tastes and scho- stic tendencies. Only in this way can we make our personnel work ›ally effective.

2. An exhaustive study of the entire problem of "student aid." The fect of part time employment, monetary gifts and easy loans on the udents' scholarship and, also, on his social and economic perspective, 'e recognized as both harmful and beneficent. When, how, to what :tent and on what grounds should a student be aided financially? ın part time employment be tied up with a student's vocational objec- ve? These and other questions press for solution.

3. The new problems forced to the front by the influx of women udents during the last four or five years. These problems are both lministrative and academic and concern themselves with the social, ıysical, scholastic, and moral welfare of the entire group. One can y without fear of contradiction that no satisfactory or lasting solu- ›n can be reached until we solve the questions of housing, recre- ional facilities, and curriculum adjustments.

WILLIAM L. MACHMER,
Dean.

REPORT OF THE DIRECTOR OF THE EXTENSION SERVICE

The number of men and women seeking and taking part in self-edu- tion is constantly increasing. Through our contacts with meetings Trustees for county aid to agriculture, we see a continual growth the work being done by the members of the county extension serv- :s. This growth shows more and more people are taking advantage an educational opportunity which comes to their communities, to eir farms and homes, increasing to a great degree the work of the ınty agents in agriculture, home-making and boy and girl clubs.

As this condition develops, it reacts directly by requiring increased :vices of our college extension staff. The problem before us of how meet this increasing demand is not an easy one to answer. We are ıtinually readjusting our time and activities in order to take on new ties. Yet, with some of our subjects, we have not been able to sat- y the requirements made upon us. In order to comply with the many ıuiries and requests that come to us for instruction in the field, we ve been asking the resident staff to give us assistance. In looking er the records, we find at least twenty members of the resident col- e and station staffs have taken part in the field work.

Looking back over the past year, there is much evidence to make believe satisfactory progress has taken place in the projects which ve been under way. Progressive work by our specialists and by the county extension services can be pointed to on the basis that increa ing requirements of them indicate their work must have been satisfa tory or the services requested would diminish rather than increase. is very seldom that our facilities meet the full demands made up us. We are unable to fill all the requests made by county extensi service managers for our specialists.

Through its educational work on the value of milk as a food, the Ne England Dairy and Food Council is well serving the dairy industry the eastern part of the state by co-operating with many of the uni composing the following:

Schools	Kindergarten Mothers Clubs
Settlements	Tuberculosis Associations
Parent-Teachers Assoc.	Dispensaries
Health Centers	Out-Patient Dept.-Hospitals
Y. W. C. A.	In-Patient Dept.-Hospitals
Y. M. C. A.	Stores
Industrial Centers	Bank-Post Office
Granges	Fairs
Red Cross	Playgrounds
N. E. Dairy Vacation	Teachers Conventions
Bible Schools	District Nursing Association

It also carries on an advertising campaign, emphasizing the fo value of milk. The extension service co-operates in this effort throu its employment of one-third of the time of the secretary, Wm. P. Lockwood.

We find there are more cow test associations in the state than ev before. About 280 herds are now numbered in the membership of t associations and these include between 2,800 and 3,000 cows. This the largest number of cows recorded in the cow test associations any one time. This trend points to the fact that there is a keen i terest by those owning herds and that more attention is being paid locating the unprofitable cow and improving the method of handli the herd.

The investigation which was made of conditions in the tuberculos eradication program has stimulated a greater interest in controlli this disease. The Hampden County Improvement League played important part in this investigation, which has resulted in an improv program for eradicating the infected cow.

In looking over the reports applying to the agronomy projects, it evident that alfalfa is receiving much attention. County agents ha been using the specialist to bring about the correct practices in see ing and handling this crop. Acreage increases are reported in near every county and successes seem more prevalent than previously.

With the orchardists, the spray service has been very valuab Specialists stationed in the field determined the proper time to spr orchards to prevent the spread of scab disease. To control scab, was necessary to find out the time the spores of this disease would expelled and then notify many growers through a telephone servic so they might cover their trees with spray material in time to preve infection. The orchardists of the state continue to hold numero meetings during all seasons of the year, taking up with the specialis many subjects in cultural and distribution problems that the growe may be well informed.

The specialist handling the subject of home storage and horticu tural manufactures sees an increasing number of his plans being p into practice on the farm. Many growers now have their own stora cellars which keep their apples in good condition until they can properly graded, packed and marketed. A larger number of perso attended canning demonstrations in 1926 than in any year since 1918

The extension specialist in market gardening has been continual n touch with the men in the industry. Demonstrations in packing and grading vegetables were given groups and individual market gardeners, ising the standards developed by the Boston Market Gardeners Asso- iation. One of the special projects of the year has been the work with his association in the grading of vegetables.

Under the subject of farm management, we find a very active in- erest on the part of poultrymen in keeping accounts in order to study he facts which they bring out. The farm management specialist re- eives these records monthly, summarizes them and returns the results. The farm management specialist also assisted the county agents in onducting several tours, on which the farmers discussed among them- elves the problems of finances, farm management and rearranging arm business, in order to get the best practical results.

The forestry project has made a beginning and we find towns and ities have been encouraged to plant town forests. A survey of the tate, taking account of the forest lands and those available for forest urposes, has been made by the state extension forester. One of the nteresting developments of the year in this subject was a trip con- lucted by the Worcester and Middlesex county extension services, howing to those who were in attendance the results of careful and in- elligent management of the farm forest, as well as the possibilities in ommercial and natural reforestation. The forestry extension project s conducted in co-operation with the Massachusetts Department of Conservation.

The home economics work of the extension service has progressed n two subjects, nutrition and clothing. While we have been able to o a little work with the subject of home management through the ervices of a specialist who was employed for a short period of time, ve have been able to meet only a small part of the demands.

Increased activities are conspicuous in the nutrition work. While ubstantial progress has been made in past years, the reports this year how there has been a fourfold increase in the number of women en- olled in project work; in the acceptance of approved projects, and in he passing on of this information to others. At the summer project neetings, able speakers stressed nutrition problems to large audiences. This has helped to spread the knowledge of the project, resulting in he marked increases noted.

The clothing project has been handicapped during the latter part of he year through the loss of Miss Knight at the time of an automobile nd train accident on Cape Cod. To date, we have not been able to find nyone to take her place.

Club work in Massachusetts has moved along very satisfactorily tate wide. Enrollments have held up, camps have been successful, nd the obtaining of local leaders has been generally successful. The rowth in the number of club members acting as local leaders has been reater than could have been expected. This has made the county ub agents look to the future and they have given much thought to he two following problems:

1. How shall the interest of the older club members be continued the work?

2. How shall the subject matter information needed by local leaders e made available?

The number of girls and boys whom we find entering college or nor- al school from club work during the past year totals 103. The con- nual entrance of club members into higher institutions of learning esults in many young people graduating from college and returning their communities as active leaders in promoting extension work.

The staff conferences held every other week give each specialist the pportunity to contribute of his experience and opinions. These con- rences do much to promote staff harmony and efficiency.

During the period between June 20th and 25th, the county agents, with the county agent leader, visited New Jersey where they were co- ducted by officials from the New Jersey extension service to the in portant agricultural sections of the state, as well as to the New Jers experiment station. This trip gave them an opportunity to see a have explained how the county agents of New Jersey were workin with the farmers in all branches of agriculture, demonstrating the mo efficient methods.

Bulletins and printed and mimeographed matter are being used whe ever possible to supplement the work of the specialists. We are r vising our list of publications as well as their contents. Mailing lis are being corrected and we intend that only those who can recei value from our publications will have their names retained.

Radio is becoming more of a factor in extension work. Sixty-tv broadcasts were given by members of the extension and college sta from WBZ and WTAG, as well as a number of miscellaneous talks fro the Houghton and Dutton studio of WEEI. These broadcasts broug over 1,200 enrollments to the radio correspondence courses, as well the receipt of 100 to 200 letters of inquiry per week. Plans for t winter of 1926-27 have been completed for broadcasting agricultur and home economics material from WEEI and WNAC in Boston a WBZ in Springfield. This material is handled in co-operation wi the U. S. Department of Agriculture.

Correspondence courses are in a transition stage. Facilities f handling them are very limited and some courses are in need of r writing. The question of how much we can do with them depends whether proper and adequate supervision can be secured. There a many opportunities to use correspondence courses to supplement oth forms of extension teaching.

Members of the extension service attended and assisted at 22 ag- cultural fairs, representing 266 days total time. At six of these, spec exhibits were supervised and at the Union Agricultural Meeting Worcester, an extensive exhibit was arranged. Farm and Home We was attended by nearly 4,000 people, many of whom commented on t practical knowledge obtained from the program.

Poultry husbandry includes, in addition to the general extension a tivities of lectures, demonstrations and visits to poultry farms havi perplexing problems, a close relationship to the Massachusetts Feder tion of Poultry Associations with a membership of 31 local associatio and the Massachusetts Association of Certified Poultry Breeder Disease control, better breeding, raising of increased amounts of gre feed and improved poultry plant organizations are problems all which come in the work outlined in the projects designed to be of a sistance to the poultry industry.

The peak of the economic trouble in the tobacco industry pass during the year, and the situation, while not yet satisfactory, is muc easier. Members of the extension and county staffs answered ma inquiries from tobacco growers.

A considerable number of changes have taken place in the extensio staff. During the year, we have been without an extension speciali in marketing, having been unable to locate a man with satisfacto training and experience who would come at the authorized salary. A a result, a most important project has lagged. Need for education work in distribution and marketing of crops is further emphasized b the New England Farm Products Marketing Conference in Boston D cember 9th and 10th, 1926. This conference focused attention on th problems which face New England farmers in the marketing and di tribution of their crops. It gave definite expression to the need fo the establishment of voluntary standards for farm products and the identification. It requested that the extension service carry on an in tensive and comprehensive educational campaign with growers to brin to their attention the value that can be obtained by using these stan rds and the brands and labels with which they can be identified. Aside rom this educational work which will need to be included in the pro- rams of most of our specialists, we shall need to carry on the work ı marketing already in hand.

Co-operation with the U. S. Department of Agriculture has continued atisfactorily.

During the next year, we plan to give special attention to the edu- ational problems of distribution and marketing agricultural products nd to the making of rural homes more convenient and attractive, as ell as reducing home makers' burdens. We hope to be able to fill ne vacant positions on the staff, though we are having difficulty in ocating suitable trained persons who will come at salaries authorized.

WILLARD A. MUNSON,
Director of the Extension Service.

REPORT OF THE DIRECTOR OF THE EXPERIMENT STATION

The year just passing has in general been prosperous. There have een fewer resignations than has been the case the past few years, the ncreased support coming from the Purnell fund has enabled the Sta- on to enlarge the scope of its work, and a new policy relative to the rinting of Experiment Station bulletins has bettered its publication ervice.

During the year work was instituted in home economics, through the ervice of Miss Helen Knowlton, who received a six months' leave of bsence from the College for this purpose. There is every reason to elieve that this important branch of work is well started. New work lso has been instituted in horticultural manufactures, and in dairy nanufactures. Owing to difficulty in finding suitably prepared men, ork long contemplated in the department of farm management has ot as yet been actually started.

The only serious loss of the year was the burning of the main build- ng of the Cranberry Station, early in the morning of May 31st, last. he action of the Governor's Council in appropriating money for the uilding and partial equipment of the Station is much appreciated, and as enabled the cranberry research to be prosecuted with a minimum f loss. Fortunately all of the records were in a fireproof safe, and ere undamaged.

Looking ahead certain slight changes in financial organization seem be necessary. The Station orchards are growing and its flocks are ncreasing. Year by year costs are increasing in the way of tillage, runing, fertilizing, feeding, spraying and marketing. Income also ncreases, varying of course with prices. Our appropriation, however, oes not increase to meet the need. In principle, allowance from an mergency fund to care for extraordinary harvesting costs is sound. n practice it is a cumbersome plan, and too inelastic to make possible ne most efficient administration. It is recommended, therefore, that his problem of financing on productive operations be given careful onsideration.

In addition to the foregoing there should be a more definite policy ith relation to professional improvement, particularly of the younger taff members. No program relative to professional improvement has ver been agreed upon, partly on account of apparent cost. This cost, owever, cannot be avoided. It must be met, and is being met, either n the salary paid to a trained person, or in time allowed to younger taff members for study, or in the poorer service received from un- rained persons. Further delay in reaching decision is dangerous.

Finally, it is gratifying to report continued progress in all of the ontrol and regulative activities vested in the Experiment Station, and articularly in the work leading to the elimination of certain poultry diseases. With the very modest increase in financial support, changes in organization have resulted in a $3389.90 increase in income, and a 33,899 increase in number of tests run during the last fiscal year. It is expected that this work for the present testing season will be completed very early in the new year. If so, then for the first time the Experiment Station will have met the real need as far as this particular service is concerned.

S. B. HASKELL,
Director of the Experiment Station.

REPORT OF THE DIRECTOR OF THE GRADUATE SCHOOL

During the past year there have been registered in the Graduate School eighty-seven students. Of this number twenty-eight were registered in the summer quarter. Due to the fact that in high schools elective subjects and elective courses are abundantly available, largely for the purpose of specialization in vocational pursuits, there have arisen in graduate schools some seriously troublesome problems. Specialization in some aspect of agriculture in much the same form may begin in the high school and continue in college and reach the graduate school. In high school and college little attention may be given to studies considered in any liberal education or basic to the vocation itself. This situation results in barring the way to professional studies because, to pursue more advanced professional studies, basic studies are required, and to pursue basic studies, there must be certain prerequisite preparation. This almost completely excludes certain types of college graduates from farther advancement unless they are willing to retrace their steps. This condition in varying degrees affects many graduate students.

At the June Commencement nine students received advanced degrees. Their names and the subjects of their theses are listed below:

Doctor of Philosophy
- Joseph Raymond Sanborn
  - Physiological Studies in Cellulose Fermentation

Master of Science
- Frederick Sheldon Bartlett
  - The Relation of Hydrogen-ion Concentration to the Speed of Inversion of Sucrose
- Martin E. Cupery
  - A Further Study of the Condensation Products of Resorcinol
- Mary Joan Foley
  - Highway Financing in Massachusetts
- Hovanes Garabedian
  - A Comparative Study of the Official Method for Determining Furfural and Pentosans and a Colorimetric Method
- Gerald Matthew Gilligan
  - The Influence of the Hydrogen-ion Concentration on the Electrolyte Requirement for the Coagulation of Bentonite Dispersions
- Donald Sewall Lacroix
  - The Life History and Control of the Cranberry Weevil *Anthonomus musculus* Say (Coleoptera: Curculionidæ) and Other Papers
- Marshall Olin Lanphear
  - An Ecological Study of Pasture Cover
- Gordon Pittinger Percival
  - The Viscosity and Surface Tension of the Principal Proteins in Ice Cream

CHARLES E. MARSHALL,
Director of the Graduate School.

REPORT OF THE DIRECTOR OF SHORT COURSES

The College awarded certificates to sixty-six graduates of the Two-ear Course in June, of whom eight were women. A total of 464 stu-ents have been graduated in seven years. A special feature of the ommencement exercises was the splendid address presented by Dr. arl Edward Ladd, Director of Extension Service, of the New York tate College of Agriculture, Cornell University.

At this time we are able to present the results of a survey, made late his fall, indicating what these most recent graduates are doing. Of ie sixty-five men, regular and special students, sent out, we find them igaged in:

Animal Husbandry or General Farming	18
Pomology or Fruit Growing	10
Poultry	9
Floriculture	6
General Horticulture	5
Dairy Manufactures	3
Vegetable Gardening	3
Taking further study	3
Non-agricultural work	1
Occupation unknown	7

Despite a serious depression in agriculture the country over, these gures indicate a satisfactory outlook for agricultural opportunities i Massachusetts.

During the summer eighty freshmen were located in positions for ieir six-months' required practice work. Our records of failure in iis type of supervised training are surprisingly low, only six men eing disqualified during the term and six others withdrawing.

Placements were distributed as follows, with average monthly wage eceived:

ajor course	No. of students	Average monthly wage
nimal Husbandry	15	$90.42
airy Manufactures	8	93.50
loriculture	13	83.54
orticulture	8	99.81
omology	11	87.82
oultry	22	84.45
egetable Gardening	3	82.67
otal earnings for the entire group		$39,113.12

Mr. Viets reports that eighty-eight employers were used to meet the aining requirements for the students. Fifty-one of these employers ere hiring students for the first time; eighteen had students placed ith them for the second time, or more; and seventeen had students ice before. It is evident that new contacts have to be made through-it the year if a sufficient number of desirable positions are to be se-ired regularly for placement training. We are extremely fortunate have this work so well organized and so smoothly functioning.

An increasing number of requests are coming to us each year to ecommend graduates for new positions. We are developing our sys-m of records to meet the needs of this new service, both for employer nd student. No graduate is recommended for a position whose quali-cations are in any way questionable. We feel it is better to leave ie position unfilled than to place a man unsuited for the work.

The growing importance of such college placement service is being ecognized by all branches of industry seeking trained men. The en-iusiastic response on the part of representatives from nearly all the ew England colleges in organizing recently an employment officers' association shows a sincere desire to meet the new demands. It worth recording here to state that our own college has assisted in th pioneer undertaking through the services of Paul W. Viets as first pre ident of the organization.

Apparently the levying of a tuition charge for the first time has n seriously affected the Two-Year enrollment. While the number freshmen, eighty-seven, is slightly less than the registration for 192 the advance inquiries for 1927 seem to be well ahead of previous year With seventy-eight seniors registered for the second year, the tot enrollment is 165.

Winter School

The 1926 Winter School had a smaller registration than usual, sixty eight students enrolling. It is possible that this phase of our work being largely supplanted by the far-reaching and intimate person service rendered by our County Extension organizations. The develop ment of the College Extension service, with its radio broadcasts an special courses, may well supply a new educational influence, dispens ing with the old. The spoken voice and personality pass through th air, much as in the classroom; only the physical presence of the in structor is lacking.

Summer School

In eliminating some of the preparatory courses in addition to stipu lating high school graduation as a minimum requirement for any wor in the summer school, a reduction in students was expected. This wa offset, however, by a slight increase in the number of teachers enrolling making our total of 168 practically the same as last year.

With excellent instructors and a well balanced program, coupled wit the summer charms of our campus, we look for an increasing apprec ation of these opportunities by the teachers of the state. The unusua recreation program made available last summer brought the joy o riding to many, and we think, like vaccination, "it will take."

New lines of work were undertaken during the year in helping financ the annual one-day program for the Massachusetts Veterinary Associ ation, as organized and directed by the Department of Veterinar Science of the College. Nearly fifty members of the association wer in attendance.

A one-week school for Country Ministers was held the last week in July co-operating with Rev. Kenneth C. MacArthur, rural secretary o the Massachusetts Federation of Churches. An attendance of twenty five gives reason to continue similar plans for another year. A large part of the program was furnished by the College staff, for whose cordial help I wish to express sincere thanks.

Our new moving picture machine is being called into frequent use and is proving a valuable agency to supply accurate visual information on the work of the College.

The new problems of teaching adjustment are being given thoughtful consideration by members of the Two-Year staff who are aiding in every way to enable our Short Courses to turn out trained workers and responsive citizens.

ROLAND H. VERBECK,
Director of Short Courses.

REPORT OF THE LIBRARIAN

There are now in the library 77,472 volumes bound and catalogued; in addition there are a large number of uncatalogued books, and over fifty thousand pamphlets. During the past year 2,406 volumes were added and catalogued. The number of department libraries at present s forty seven, including the Market Garden Field Station at Waltham and the Cranberry Field Station at Wareham. The volumes in these department libraries are all catalogued in the main library, so that all books belonging to the college are available to all members of the college.

During the period since the last annual report, numerous changes have been made in the library. The list of periodicals subscribed to by the library has been revised by painstaking efforts of the library committee and considerable saving has been made without depriving any department of necessary material. All the lights in the building have been altered so that instead of being visible, all are now shaded, thus preventing eye strain for readers from whom there had been constant complaint. The amount of current was also lessened in this way about one third, although the actual illumination is doubled in most cases. The wiring has been so altered that all current is cut off from the building at night; thus risk of fire when the building is without occupants is greatly reduced. All magazines likely to be of use to readers are now kept in the reading room in a simple arrangement, so that much time is saved for readers in consulting them. All the books in the building have been reshelved so that they are now in order, and space is allowed for growth for several years. The gallery has been provided with inexpensive shelving and these have been filled with books less often consulted. The tower has also been opened for library use and space for over five thousand volumes, besides an attractive study alcove, has been thus gained. The basement, which was in almost incredible disorder, has been almost entirely gotten into order, and will be entirely so within a few months. The College History Collection has been largely put in order. The library is looking forward to the gift to this collection by Professor Waugh, of many of his well known portrait photographs of men connected with the college. Large numbers of books in disrepair and lacking labels have been repaired or labelled, chiefly by student labor, properly supervised. The catalog has been moved from a back corner of the stack room to a place beside the main entrance, thus permitting much readier use and making a much more convenient entrance to the main floor and better access to the reference and circulation desk.

The pamphlet collection, which is large and valuable has been largely placed in order and work upon it is actively being done.

The diligent and intelligent service of the library staff in all these changes and improvements, which have involved over-work for long periods cannot be over praised and certainly deserve such recognition as it is possible to give them.

The overwhelming need of the library at the present time is to be made safe from fire; its loss would be an irreparable blow to the college and the electric wiring now in place is exceedingly dangerous. Of course more space is needed, especially for the work of the staff, but the building as it is at present allows room for the number of students now in the college and for considerably more books than are now housed in the building. The building is well lighted and well warmed, and its very compactness is a distinct element of convenience and permits the rapid service which students now find in using the library.

Basil B. Wood,
Librarian.

Table I.—New Appointments.

A. In the Academic Departments.

Assistant Professor of Farm Management: Rollin H. Barrett, B.S., Connecticut Agricultural College, 1919; M.S., Cornell, 1926.

Stenographer, Division of Horticulture: Edith E. Benson.

Instructor in Mathematics: Harold D. Boutelle, B.S., Worcester Polytechnic Institute, 1920; Ch.E., 1922.

Instructor in Physical Education: Philip H. Couhig, B.Sc., Massachusetts Agricultural College, 1926.

Assistant Professor of Agronomy: Miles H. Cubbon, B.Sc., Cornell, 1921; Ph.D., 1925.

Assistant Professor of Rural Sociology: Frederick M. Cutler, A.B., Columbia, B.D., Union Theological Seminary, 1898; Ph.D., Clark, 1922

Instructor in German: L. Leland Durkee, B.Sc., Massachusetts Agricultural College, 1926.

Instructor in Entomology and Bookkeeping: Clayton L. Farrar, B.S. Kansas State Agricultural College, 1926.

Professor and Head of the Department of Dairying and Animal Husbandry: Julius H. Frandsen, B.S.A., Iowa State College, 1902; M.S.A., 1904.

Instructor in Microbiology: James E. Fuller, A.B., Colorado College 1911; A.M., 1925.

Instructor in Zoology: Chauncey M. Gilbert, B.Sc., Massachusetts Agricultural College, 1925.

Field Agent: William I. Goodwin, B.Sc., Massachusetts Agricultural College, 1920.

Bookkeeper: Mary E. Honnay.

Clerk, Treasurer's Office: Edna E. Kahler.

Library Assistant: Mrs. Nan L. Kelly.

Instructor in Agronomy: Oliver W. Kelly, B.Sc., Colorado Agricultural College, 1924.

Instructor in English: Alfred Nicholson, A.B., Princeton, 1921; M.A. 1926.

Instructor in Pomology: Oliver C. Roberts, B.Sc., Massachusetts Agricultural College, 1919.

Instructor in Vegetable Gardening: Gerald J. Stout, B.S., Michigan State College, 1924; M.S., 1926.

Stenographer, Short Courses: Kathryn V. Toole.

Assistant Professor Home Economics: Marion L. Tucker, B.S., Columbia, 1914.

Curator in Chemistry: Edwin O. Turner.

B. In the Experiment Station.

Assistant Research Professor of Botany: Linus H. Jones, B.Sc., Massachusetts Agricultural College, 1916; M.Sc., 1919; Ph.D., Rutgers, 1922.

Investigator in Pomology: Ray G. Smiley, B.Sc., Massachusetts Agricultural College, 1926.

C. On Purnell Funds.

Clerk, Department of Agricultural Economics: Marian V. Brown, B.A., Wellesley, 1926.

D. In the Control Service.

Analyst: Marvin W. Goodwin, B.Sc., Massachusetts Agricultural College, 1926.

Specialist: Henry Van Roekel, D.V.M., Iowa State College, 1925; M.S., Virginia Polytechnic Institute, 1926.

Field Agent: Clifton B. Waite.

E. In the Extension Service

Assistant State Club Leader: Marion E. Forbes, Framingham Normal School, 1919.

tenographer: Olive L. Gillett.
hief Clerk: Ruth E. Merrick, A.B., Mount Holyoke, 1922.
irector: Willard A. Munson, B.Sc., Massachusetts Agricultural College, 1905.
xtension Editor: Grunow O. Oleson, B.S.A., University of Wisconsin, 1925; M.S.A., 1926.
lerk: Lora A. Ward.
tenographer: Ethel M. Wood.

TABLE II.—SPEAKERS FOR THE YEAR

A. Speakers at Assembly for the year ending Nov. 30, 1926

1925

ec. 3. Mr. Royal B. Farnum, Boston.
ec. 10. Rev. J. Burford Parry, Springfield.

1926

in. 6. Mr. Adam Wilkinson, Holyoke.
in. 13. Professor David Morton, Amherst College.
in. 20. Mr. Clifford Marle, Northampton.
in. 27. Major N. B. Briscoe, M.A.C.
eb. 3. Mr. Charles E. Westervelt, Northampton.
eb. 17. Student forum.
eb. 24. Professor Dallas Lore Sharp, Hingham.
ar. 3. Mr. Frank L. Boyden, Deerfield.
ar. 10. Professor Harry F. Ward, New York City.
ar. 31. Mr. M. S. Sherman, Springfield.
pr. 7. Mr. Edward C. R. Bagley, Boston.
pr. 14. Mr. Gaylord W. Douglass, Wilbraham.
pr. 21. Professor Lawrence B. Packard, Amherst College.
pr. 28. Mr. John F. McNamara, Northampton.
ay 5. Student forum.
ay 19. Mr. John D. Willard, M.A.C.
ay 26. President Edward M. Lewis, M.A.C.
ept. 16. President Edward M. Lewis, M.A.C.
ept. 23. Mr. W. H. Kendrick, Morgantown, W. Va.
ct. 14. Mr. M. J. Brines, Boston.
ct. 21. Mr. James T. Nicholson, Washington, D. C.
ct. 28. Mr. Charles H. Gould, Haydenville.
ov. 4. Professor Frank P. Rand, M.A.C.
ov. 11. Professor John M. Tyler, Amherst.
ov. 18. Mr. Waitstill Sharp, Boston.
ec. 2. Student forum.
ec. 9. Mr. Ramsay Muir, London.

B. Speakers at Sunday Chapel for year ending Nov. 30, 1926

1925

ec. 6. Rev. Edwin B. Robinson, Holyoke.
ec. 13. Bishop W. F. Anderson, Boston.

1926

n. 10. Principal Alfred E. Stearns, Andover.
n. 17. Rev. Samuel A. Eliot, Boston.
n. 24. Bishop Edwin H. Hughes, Chicago.
n. 31. Mr. Wiley H. Swift, New York City.
eb. 7. Dean Charles R. Brown, New Haven, Conn.
eb. 14. Rev. Daniel C. Evans, Cambridge.
eb. 28. President Paul D. Moody, Middlebury, Vt.
ar. 7. Rev. Joseph H. Twichell, Williamstown.
ar. 14. Rev. Frank W. Padelford, New York City.
pr. 11. Rev. John B. Hanna, M.A.C.

Apr. 25. Mr. Albert E. Roberts, New York City.
May 2. Rev. Nehemiah Boynton, New York City.
Nov. 7. Rev. Robert R. Wicks, Holyoke.
Nov. 14. Rev. A. L. Kinsolving, Amherst.
Nov. 21. Dr. William I. Chamberlain, New York City.

TABLE III.—ATTENDANCE.

	Registration Nov. 1, 1925			Registration Nov. 1, 1926		
A. In Work of College Grade.	Men	Women	Total	Men	Women	Total
Graduate Students	42	5	47	33	6	39
Senior Class	90	15	105	77	10	87
Junior Class	83	11	94	89	21	110
Sophomore Class	110	28	138	115	30	145
Freshman Class	140	39	179	150	35	184
Special Students	4	5	9	4	–	4
Totals	469	103	572	468	102	570
B. Short Course Enrollment.						
Two-year Course, second year	75	9	84	69	9	78
Two-year Course, first year	93	12	105	78	9	87
Vocational Poultry Course	3	–	3	6	–	6
Two-year Course, special students	–	–	–	–	–	–
Totals	171	21	192	153	18	171
C. Other Short Course Enrollment.						
Winter School	76	10	86	58	10	68
Summer School	58	113	171	51	116	167
Totals	134	123	257	109	126	235

D. Convention Registration.

	1925.	1926
University Extension Industrial Institute	–	5[illegible]
Polish Farmers' Day	175	22[illegible]
Farmers' Week and Annual Poultry Convention	3,000	3,50[illegible]
Junior Boys' and Girls' Prize Winners' Camp	125	11[illegible]
Extension Workers' Conference	100	10[illegible]
Women's Clubs	50	-[illegible]
Lawn Day	67	2[illegible]
School for Veterinarians	52	7[illegible]
Meeting of Grange Lecturers	100	-
Hampshire County Fruit Meeting	35	-
Tri-State Conference on Clothing	50	-
Middlesex County Club Champions	100	8[illegible]
Camp Vail Training School	40	-
Regional Meeting of Fertilizer Dealers and Manufacturers	–	7[illegible]
High School Day	636	71[illegible]
	4,530	4,962

Table IV.—Statistics of Freshmen entering Massachusetts Agricultural College, September, 1926.

A. *Home Addresses of Students (classified by Towns and Cities)*

Adams	2
Agawam	1
Allentown, Pa.	1
Amesbury	1
Amherst	9
Andover	1
Ashfield	1
Astoria, L. I.	1
Attleboro	4
Auburn	1
Bangkok, Siam	1
Barre	1
Belchertown	1
Belmont	2
Berlin	1
Bethany, Conn.	1
Beverly	1
Boston	9
Boxford	1
Bridgewater	1
Brimfield	1
Brockton	2
Brooklyn, N. Y.	1
Cambridge	1
Chatham, N. Y.	1
Chicopee	2
Colrain	1
Cummington	1
Dalton	1
Dartmouth	1
Daytona Beach, Fla.	1
Dedham	1
Dover	1
Eastham	1
Easthampton	1
Fall River	1
Fitchburg	3
Framingham	2
Franklin	1
Georgetown	1
Gloucester	4
Goshen	1
Greenfield	5
Greenwich, Conn.	1
Hadley	1
Hamilton	1
Haverhill	1
Hardwick	1
Holbrook	1
Holyoke	9
Jacksonville, Fla.	1
Lawrence	1
Lee	1
Leominster	2
Leyden	2
Little Compton, R. I.	1
Lucea, Jamaica, B. W. I.	1
Lynn	2
Malden	1
Marblehead	1
Melrose	1
Mendon	2
Merrimac	2
Methuen	1
Milford	1
Millbury	1
Millis	1
Monson	1
Natick	1
Needham	3
New Haven, Conn.	2
Newton	2
North Adams	1
Northampton	2
Northbridge	1
Northfield, Vt.	1
Norton	1
Orange	1
Otis	1
Palmer	1
Pepperell	1
Pittsfield	2
Plainfield	1
Plainville	1
Plymouth	1
Provincetown	1
Pugwash, Nova Scotia	1
Quincy	1
Reading	1
Ridgewood, N. J.	1
Rowe	1
Rowley	1
Salem	1
Sandwich	1
Schenectady, N. Y.	1
Sheffield	1
Somerset	1
Somerville	2
Southbridge	4
Springfield	9
Springfield, Vt.	1
Sterling	1
Stoneham	1
Taunton	2
Walpole	3
Webster	1
West Boylston	1
Westminster	1
West Springfield	1
Weymouth	1
Winthrop	1
Worcester	7

B. *Home Addresses (classified by States and Countries)*

	Number	Per Cent.
Connecticut	3	1.62
Florida	2	1.08
Jamaica, B. W. I.	1	.54
Massachusetts	168	90.81
New Jersey	1	.54
New York	4	2.16
Nova Scotia	1	.54
Pennsylvania	1	.54
Rhode Island	1	.54
Siam	1	.54
Vermont	2	1.08
	185	99.99

C. *Home Addresses (classified by Counties of Massachusetts)*

	Number	Per Cent.
Barnstable	3	1.79
Berkshire	10	5.95
Bristol	10	5.95
Essex	20	11.91
Franklin	10	5.95
Hampden	25	14.88
Hampshire	19	11.31
Middlesex	15	8.93
Norfolk	14	8.33
Plymouth	4	2.38
Suffolk	10	5.95
Worcester	28	16.66
	168	99.99

D. *Nativity of Parents*

	Number	Per Cent.
Neither parent foreign born	114	61.62
Both parents foreign born	42	22.70
Father (only) foreign born	11	5.94
Mother (only) foreign born	18	9.74
	185	100.00

E. Education of Father

	Number	Per Cent
Common School	80	43.
High School	45	24.
Business School	16	8.
College or University	31	16.
No statistics	13	7.
	185	100.

F. Occupation of Father

	Number	Per Cent
Agriculture and Horticulture	38	20.
Artisans	34	18.
Business	67	36.
Professional	15	8.
Miscellaneous	14	7.
Deceased or no statistics	17	9.
	185	99.

G. Intended Vocation of Student

	Men	Women	Total	Per Cent
Farming	27		27	14.59
Landscape Gardening	19	1	20	10.81
Floriculture	9		9	4.86
Entomology	2		2	1.08
Chemistry	24	4	28	15.13
Forestry	11		11	5.94
Agricultural Teaching	3		3	1.62
Other Agricultural Work	3		3	1.62
Engineering	4		4	2.16
General Teaching	10	10	20	10.81
Religious and Social Work		1	1	.54
Medicine	6	2	8	4.32
Law	2		2	1.08
Journalism		1	1	.54
Business	4		4	2.16
Domestic Science Teaching		4	4	2.16
Extension Service	1	4	5	2.70
Library Work		1	1	.54
Undecided	25	7	32	17.29
	150	35	185	99.95

H. Farm Experience

Brought up on a farm	39	9	48	25.94
Not brought up on a farm and having no or practically no farm experience	65	23	88	47.57
Not brought up on a farm but having had some farm experience	46	3	49	26.48
	150	35	185	99.99

I. Miscellaneous Statistics

Average age (years)	18.8

REPORT OF THE TREASURER

For the Fiscal Year Ending November 30, 1926.

Balance Sheet

1925		Debit	Credit
Dec. 1.	To balance on hand	$40,022.14	

1926		Debit	Credit
Nov. 30.	To departmental income . .	188,950.75	
Nov. 30.	To Receipts from State Treasurer	719,258.78	
Nov. 30.	To refunds to State Treasurer .	6,526.37	
Nov. 30.	To Receipts from United States Treasurer	126,868.08	
Nov. 30.	To bills paid by State Treasurer .	209,725.32	
Nov. 30.	To Refunds transferred to State Treasurer		$6,526.37
Nov. 30.	Expenditures for fiscal year . .		1,052,988.27
Nov. 30.	Income transferred to State Treasurer		188,950.75
Nov. 30.	Balance on hand		42,886.05
		$1,291,351.44	$1,291,351.44

Statement of Legislative Apportionment and Expenditures for Fiscal Year Ending November 30, 1926 and Apportionment Requested for 1927

	Apportionment for last fiscal year		Expenditures		Requested Apportionment for new fiscal year	
College:						
Personal Services . .	$367,300.00		$391,134.94		$408,500.00	
Maintenance . . .	240,936.83		186,488.50		187,000.00	
		$608,236.83		$577,623.44		$595,500.00
Experiment Station:						
Personal Service . .	$79,000.00		$81,044.83		$79,000.00	
Maintenance . . .	19,590.53		17,455.44		19,500.00	
		$98,590.53		$98,500.27		$98,500.00
Extension Service:						
Personal Services . .	$50,500.00		$48,934.74		$51,500.00	
Maintenance . . .	33,274.53		34,935.66		35,000.00	
		$83,774.53		$83,870.40		$86,500.00
Short Courses:						
Personal Service . .	$60,600.00		$55,649.12		$62,400.00	
Maintenance . . .	12,253.76		10,718.81		13,000.00	
		$72,853.76		$66,367.93		$75,400.00
Market Garden Field Station:						
Personal Service . .	$7,500.00		$7,521.07		$8,000.00	
Maintenance . . .	5,005.11		5,019.23		6,000.00	
		$12,505.11		$12,540.30		$14,000.00
Trustees travel . . .	$1,200.00		$831.10		$1,200.00	
Printing reports . .	2,099.40		1,225.24		2,000.00	
Commercial feedstuffs .	10,000.00		9,823.39		10,000.00	
		$13,299.40		$11,879.73		$13,200.00
Fertilizer law . . .	$13,500.00		$13,430.25		$13,500.00	
Poultry law . . .	10,001.63		9,941.04		10,000.00	
Milk testing law . .	600.00		587.34		600.00	
		$24,101.63		$23,958.63		$24,100.00
Replacements . . .	$17,340.33	$17,340.33	$17,977.85	$17,977.85	$25,000.00	$25,000.00
Emergenccy . . .	5,000.00	5,000.00	1,053.35	1,053.35	5,000.00	5,000.00
Totals . . .		$935,702.12		$893,771.90		$937,200.00
Balance unexpended .				41,930.22		
				$935,702.12		

Cash Statement

	Other Funds	State Funds	Totals
Balance December 1, 1925 .	$40,022.14		$40,022.14
Receipts.			
College Receipts from Students and others			39,503.99
Tuition		$16,250.00	
Laboratory fees		6,165.39	
Rent		17,088.60	
Department Sales			80,653.55
Products		70,454.50	
Miscellaneous		10,199.05	

	Other Funds	State Funds	Totals
Experiment Station . .			16,502.10
Cranberry receipts . .		7,580.87	
Chemical receipts . .		464.36	
Miscellaneous . . .		8,456.87	
Extension Service . . .			1,071.84
Correspondence . . .		873.34	
Miscellaneous . . .		198.50	
Short Courses . . .			7,439.07
Students' fees . . .		7,148.07	
Winter School . . .		290.00	
Miscellaneous . . .		1.00	
Market Garden Field Station .			1,086.98
Produce		1,086.98	
Feed Law		18,234.69	18,234.69
Fertilizer Law . . .		14,691.33	14,691.33
Milk Testing Law . . .		1,026.75	1,026.75
Poultry Disease Law . .		8,740.45	8,740.45
Treasurer of the Commonwealth			719,258.78
Maintenance . . .		695,459.10	
Special Appropriations .		18,486.36	
Endowment . . .	3,313.32		
Department of Education .	2,000.00		
Federal Government . .			126,868.08
Land Grant of 1862 . .	7,300.00		
Hatch Fund of 1887 . .	15,000.00		
Morrill Fund of 1890 . .	16,666.67		
Adams Fund of 1906 . .	15,000.00		
Nelson Fund of 1907 . .	16,666.66		
Smith Lever Fund of 1914 .	31,234.75		
Short Courses, Federal Project	....		
Purnell Fund of 1925 . .	25,000.00		
Bills paid by State Treasurer .		209,725.32	209,725.32
	$172,203.54	$1,112,621.53	$1,284,825.07

Payments.

	Other Funds	State Funds	Totals
College expense . . .			$623,570.09
Personal Service . . .	$45,946.65	$391,134.94	
Maintenance . . .		186,488.50	
Experiment Station . .			150,571.51
Personal Service . . .	48,096.08	81,044.83	
Maintenance . . .	3,975.16	17,455.44	
Extension Service . . .			114,800.50
Personal Service . . .	28,555.38	48,934.74	
Maintenance . . .	2,374.72	34,935.66	
Short Courses . . .			66,737.43
Personal Service . . .	220.83	55,649.12	
Maintenance . . .	148.67	10,718.81	
Market Garden Field Station .			
Personal Service . . .		7,521.07	12,540.30
Maintenance . . .		5,019.23	
Trustees Travel . . .		831.10	831.10
Printing Reports . . .		1,225.24	1,225.24
Replacements . . .		17,977.85	17,977.85
Commercial Feedstuffs . .		9,823.39	9,823.39
Fertilizer Law . . .		13,430.25	13,430.25
Milk Testing Law . . .		587.34	587.34
Poultry Disease Law . .		9,941.04	9,941.04

	Other Funds	State Funds	Totals
ecial Appropriations			24,425.86
1925 Emergency needs		669.36	
1925 Livestock replacement		1,804.83	
1926 Emergency needs		1,053.35	
1926 Foreman's Quarters Tillson Farm		6,000.00	
1926 Repairs to Physics Building		4,000.00	
1926 Brooder House		1,800.00	
1926 Certain Barns		9,098.32	
come		188,950.75	188,950.75
funds to State Treasurer		6,526.37	6,526.37
lance	42,886.05		42,886.05
	$172,203.54	$1,112,621.53	$1,284,825.07

Budget Appropriation for Current Expenses for Year Ending Nov. *30, 1926*

rsonal Services:	Appropriation	Current Year	Balances
Administration	$35,300.00	$33,387.02	$1,912.98
Instruction	203,000.00	197,650.67	5,349.33
Maintenance	129,000.00		—15,615.77
Departmental		74,544.96	
Farm		29,693.19	
Operating		40,377.62	
pairs Ordinary		15,481.48	—15,481.48
placements		1,794.49	—1,794.49
periment Station	79,000.00	81,044.83	—2,044.83
rtilizer Control Law		10,384.11	—10,384.11
ultry Disease Law		6,649.89	—6,649.89
lk Testing Inspection Law		360.00	—360.00
mmercial Feedstuffs		7,387.95	—7,387.95
tension Service	50,500.00	48,934.74	1,565.26
rket Garden Field Station	7,500.00	7,521.07	—21.07
ort Courses	60,600.00	55,649.12	4,950.88
Total Personal Services	$564,900.00	$610,861.14	$—45,961.14
avel	$42,589.11	$6,268.26	$4,856.23
ice and other Expenses		31,464.62	
aching and Laboratory Supplies	56,349.46	44,924.18	3,283.15
nor Equipment		8,142.13	
periment Station:			
Supplies and Equipment	15,589.75	13,678.46	1,911.29
Travel	4,000.78	2,504.80	223.80
Office Expenses		1,272.18	
tension Services:			
Supplies and Equipment	33,274.53	15,354.67	—1,661.13
Travel		19,580.99	
rket Garden Field Station	5,005.11	5,019.23	—14.12
ort Courses:			
Travel	12,253.76	1,241.90	1,534.95
Office and other Expenses		9,476.91	
at, Light and Power	94,699.88	66,583.39	28,116.49
rm	22,198.66	14,785.31	7,413.35
pairs Ordinary	25,099.72	14,320.61	10,779.11
placements	17,340.33	16,183.36	1,156.97
rtilizer Control Law:			
Travel	13,500.00	1,116.16	10,453.86
Office and other Expenses		1,929.98	

	Appropriation	Current Year	Balance
Poultry Disease Law:			
Travel	10,001.63	1,522.60	6,710[illegible]8
Office and other Expenses		1,768.55	
Milk Testing Inspection Law			
Travel	600.00	224.18	372[illegible]6
Office and other Expenses		3.16	
Trustee's Expenses	1,200.00	831.10	368[illegible]0
Printing Reports	2,099.40	1,225.24	874[illegible]6
Commercial Feedstuffs			
Travel	10,000.00	689.37	7,564[illegible]6
Office and other Expenses		1,746.07	
Total	$930,702.12	$892,718.55	$37,98[illegible]7

College Dept.:	Appropriation	Current Year	Balance
Dean's Office	$7,420.26	$7,256.13	$164[illegible]3
Executive Order	7,742.79	8,911.32	—1,168[illegible]3
President's Office	19,214.71	19,158.69	5[illegible]2
Registrar's Office	2,940.00	2,935.81	[illegible]9
Treasurer's Office	18,915.18	18,888.09	2[illegible]9
Agricultural Economics	9,332.03	9,331.81	[illegible]2
Agricultural Education	6,416.81	6,308.71	108[illegible]0
Agronomy	7,507.25	7,557.96	—5[illegible]1
Animal Husbandry	3,270.00	3,561.52	—29[illegible]2
Beekeeping	2,525.00	2,504.78	2[illegible]2
Botany	12,144.18	12,242.82	—9[illegible]4
Chemistry	18,915.58	18,909.03	[illegible]55
Dairying	37,092.65	37,978.47	—88[illegible]2
Economics and Sociology	4,215.01	4,130.76	8[illegible]25
Entomology	9,276.00	9,212.53	6[illegible]17
Farm	47,987.22	48,267.13	—27[illegible]91
Farm Management	5,814.75	5,722.26	9[illegible]49
Floriculture	11,621.67	11,586.62	3[illegible]05
Forestry	2,772.43	2,716.37	5[illegible]06
Freshman Agriculture	200.00	90.44	10[illegible]56
General Agriculture	4,795.00	5,010.96	—21[illegible]96
General Expense	166.07	2,625.94	—2,45[illegible]37
General Horticulture	18,271.51	17,493.98	77[illegible]53
Graduate School	200.00	60.30	13[illegible]70
Grounds	10,317.74	10,474.36	—15[illegible]62
Horticultural Mfg.	7,480.72	7,088.12	39[illegible]60
Hospital	4,000.00	4,533.94	—53[illegible]4
Landscape Gardening	6,917.00	6,941.41	—2[illegible]41
Language and Literature	18,396.28	18,288.94	10[illegible]34
Library	17,137.86	17,708.05	—57[illegible]19
Mathematics	7,915.00	7,841.05	7[illegible]5
Microbiology	10,351.00	10,264.67	8[illegible]33
Military Science	2,779.73	2,778.13	[illegible]60
Mount Toby	2,504.90	2,477.24	2[illegible]66
Physical Education	12,635.00	12,772.14	—13[illegible]14
Physics	5,490.00	5,502.53	—1[illegible]53
Operating and Maintenance	172,156.33	144,761.31	27,39[illegible]02
Pomology	12,020.00	12,158.05	—13[illegible]05
Poultry	25,024.46	25,410.79	—38[illegible]33
Rural Engineering	5,207.50	5,183.19	2[illegible]31
Rural Home Life	10,719.38	10,584.34	13[illegible]04
Rural Sociology	775.00	691.70	8[illegible]30
Vegetable Gardening	7,181.61	6,843.13	33[illegible]18
Veterinary	10,667.50	10,690.65	—2[illegible]15
Women's Dormitory	3,634.60	3,988.87	—35[illegible]27

	Appropriation	Current Year	Balance
Zoology and Geology	4,120.00	4,140.25	—20.25
Salary Surplus	7,262.31		7,262.31
Replacement Surplus	68.83		68.83
Total College Expenses	$623,518.85	$593,585.29	$29,933.56
xperiment Station Dept.:			
Administration	$10,503.13	$10,448.81	$54.32
Agric. Economics	100.00	106.17	—6.17
Agric. Engineering	100.00	92.53	7.47
Agronomy	6,633.22	6,695.38	—62.16
Botany	11,067.50	11,112.04	—44.54
Chemistry	12,407.27	12,546.10	—138.83
Cranberry	9,365.30	9,265.68	99.62
Entomology	7,831.34	7,647.63	183.71
Farm Management	–	–	–
Freight and Express	300.00	223.44	76.56
Library	700.00	561.70	138.30
Market Garden Field Station	2,745.00	2,745.00	
Meteorology	1,100.00	1,088.40	11.60
Microbiology	2,585.33	2,582.52	2.81
Pomology	6,860.02	7,028.28	—168.26
Poultry	9,839.95	9,974.23	—134.28
Station Service	12,983.29	12,721.12	262.17
Veterinary Science	4,515.00	4,436.62	78.38
Fertilizer Control Law	13,500.00	13,430.25	69.75
Poultry Disease Law	10,001.63	9,941.04	60.59
Milk Testing Inspection Law	600.00	587.34	12.66
Commercial Feedstuffs	10,000.00	9,823.39	176.61
Salary Surplus	—287.51		—287.51
General Horticulture	150.00	103.82	46.18
Total Experiment Station	$133,600.47	$133,161.49	$438.98
tension Service Dept.:			
Administration	$17,611.71	$19,162.66	—$1,550.95
Animal Husbandry	1,852.00	2,044.39	—192.39
Animal Pathology	150.00		150.00
Clothing	3,136.00	1,915.24	1,220.76
Co-op. Marketing	3,575.00	74.52	3,500.48
Correspondence Courses	3,410.27	3,413.59	—3.32
County Agents	2,812.93	3,103.12	—290.19
Crop Protection	100.00	12.50	87.50
Dairying	1,550.00	1,566.41	—16.41
Exhibits	1,930.00	1,998.93	—68.93
Extension Courses At College	4,190.00	4,925.81	—735.81
Extension Schools	250.00	1.28	248.72
Farm Management	2,342.00	1,842.47	499.53
Forestry	75.00	60.00	15.00
Gardening	2,462.00	5,076.38	—2,614.38
Home Demonstrations	2,913.30	3,924.30	—1,011.00
Horticultural Mfg.	3,751.75	3,021.38	730.37
Household Management	800.00	598.45	201.55
Junior Extension	11,409.82	13,773.95	—2,364.13
Landscape Gardening	325.00	207.30	117.70
Lectures	200.00	41.47	158.53
Library Extension	125.00		125.00
Nutrition	2,998.50	2,658.17	340.33
Pomology	2,972.00	3,141.68	—169.68
Poultry Husbandry	3,702.70	3,069.08	633.62

	Appropriation	Current Year	Balan[illegible]s
Printing	6,829.05	5,934.42	894[illegible]3
Rural Engineering	175.00	75.83	99[illegible]7
Soils and Crops	2,775.50	2,864.07	—88[illegible]7
	$84,424.53	$84,507.40	$—82[illegible]7
Miscellaneous:			
Short Courses			
Agricultural Economics	$505.38	$481.38	$24[illegible]0
Agronomy	3,735.35	3,586.92	148[illegible]3
Animal Husbandry	3,300.00	3,200.00	100[illegible]0
Dairying	5,620.00	5,774.91	—154[illegible]1
Entomology	100.00	93.94	6[illegible]6
Farm Management	1,085.40	1,077.07	8[illegible]3
Floriculture	2,970.15	2,976.72	6[illegible]7
Forestry	25.00	21.64	3[illegible]6
General Horticulture	2,230.87	2,219.71	11[illegible]6
Home Economics	1,589.28	1,494.86	94[illegible]2
Horticultural Mfg.	699.33	298.11	401[illegible]2
Library	100.00	77.28	22[illegible]2
Microbiology	50.00	42.62	7[illegible]8
Office	24,478.78	24,098.48	380[illegible]0
Physical Education	1,990.00	1,970.49	19[illegible]1
Pomology	8,327.85	7,979.05	348[illegible]0
Poultry	2,635.00	2,635.00	
Rural Engineering	5,680.41	5,639.59	40[illegible]2
Treasurer's Office	200.00	159.12	40[illegible]8
Vegetable Gardening	2,580.08	2,541.04	39[illegible]4
Salary Surplus	4,950.88		4,950[illegible]8
Total Short Courses	$72,853.76	$66,357.93	$6,485[illegible]3
Market Garden Field Station	$13,005.11	$13,040.10	$—34[illegible]9
Trustee's Expenses	1,200.00	831.10	368[illegible]0
Printing Reports	2,099.40	1,225.24	874[illegible]6
	$930,702.12	$892,718.55	$37,983[illegible]7

Special Appropriations.

	Appropriations	Expenditures to date	Balan[illegible]s
1925 Emergency Fund	$669.36	$669.36	
1925 Livestock Replacement	1,804.84	1,804.83	$[illegible]
1926 Emergency Fund	5,000.00	1,053.35	3,946[illegible]
1926 Foreman's Quarters Tillson	6,000.00	6,000.00	
1926 Repairs to Physics Bldg.	4,000.00	4,000.00	
1926 Brooder House	1,800.00	1,800.00	
1926 Certain Barns	11,200.00	9,098.32	2,101[illegible]
Total Special Appropriations	$30,474.20	$24,425.86	$6,048[illegible]

College Buildings (Estimated Value 1926)

	Inventory at beginning of year.	Per Cent. deducted.	Value at beginning of year less deterioration.	Repairs and Improvements during year.	Total value at close of fiscal year.
ms Hall	122,584.47	2	120,132.78	361.99	120,494.77
ary	2,856.18	2	2,799.06	6.10	2,805.16
hier's House	2,328.42	5	2,212.00	245.90	2,457.90
mistry Store House	47.59	2	46.64		46.64
rk Hall	58,912.95	2	57,734.69	1,687.12	59,421.81
l Storage Laboratory	9,786.77	2	9,591.03	23.48	9,614.51
ry Barns and Storage	28,968.72	3	28,099.66	392.69	28,492.35
per Hall	74,154.79	3	71,930.15	2,111.28	74,041.43
l Hall and Gun Shed	8,737.41	5	8,300.54	686.25	8,986.79
fee Glass House, old	6,745.24	5	6,407.98	38.37	6,446.35
fee Glass House, new	9,700.05	5	9,215.05	5.41	9,220.46
m Blacksmith Shop	393.42	3	381.62		381.62
m Bungalow No. 1	2,439.34	3	2,366.16	49.42	2,415.58
m Bungalow No. 2	4,221.86	3	4,095.20	71.73	4,166.93
m Bungalow No. 3	4,081.78	3	3,959.33	124.45	4,083.78
m House No. 1	3,208.35	3	3,112.10	178.82	3,290.92
m Bull Pens and Fence	4,171.85	5	3,963.26		3,963.26
nald Hall	68,250.64	2	66,885.63	603.73	67,489.36
it Laboratory	70,073.86	2	68,672.38	618.28	69,290.66
nch Hall	45,357.30	2	44,450.15	202.50	44,652.65
ssmann Laboratory	283,593.56	2	277,921.69	1,433.91	279,355.60
nnell Arena	8,395.43	2	8,227.52	298.37	8,525.89
und Tool Shed	171.09	5	162.54		162.54
low House	1,921.59	5	1,825.51	.60	1,826.11
se Barn	4,465.79	3	4,331.82	127.85	4,459.67
d Division of Horticulure	2,952.86	5	2,805.22	50.69	2,855.91
ticultural Barn	3,782.78	3	3,669.30	40.08	3,709.38
ticultural Garage	1,443.40	3	1,400.10		1,400.10
ticultural Tool Shed	5,002.60	3	4,902.52	.65	4,903.17
ticultural Open Shed	401.41	5	381.34		381.34
ticultural Manufacires Shed	2,952.42	5	2,804.80	3.52	2,808.32
pital	15,702.56	2	15,398.51	331.06	15,729.57
ett House and Barn	3,086.16	5	2,931.85	28.97	2,960.82
hinery Barn	3,389.75	3	3,288.06	232.14	3,520.20
ket Garden Field reenhouse	14,000.00	2	13,720.00		13,720.00
ket Garden Field Staon Office and Laboraory Building	8,000.00	2	7,840.00		7,840.00
ket Garden Field Staon Farmhouse	5,700.00	5	5,415.00		5,415.00
ket Garden Field Staon Ice House	95.00	5	90.25		90.25
ket Garden Field Staon Large Cow Barn	8,550.00	5	8,122.50		8,122.50
ket Garden Field Staon Small Stock Barn	1,900.00	5	1,805.00		1,805.00
ket Garden Field Staon Small Shed	760.00	5	714.00		714.00
hematical Building	4,804.42	5	4,564.20	57.86	4,622.06
norial Hall	98,718.68	2	96,744.31	642.66	97,386.97
robiology Building	54,452.73	2	53,363.68	469.10	53,832.78
tary Storage	174.58	5	165.85		165.85
int Toby House and arn	3,126.20	5	2,969.89		2,969.89
th Dormitory	28,996.10	2	28,416.18	371.89	28,788.07
ge Laboratory and Stae	23,143.10	2	22,680.24	283.23	22,963.47
sics Laboratory	4,638.80	5	4,406.86	4,930.51	9,337.37
gery	2,641.88	3	2,562.62	5.94	2,568.56
ltry Departments					
o. 1 Demonstration Building	1,968.53	2	1,929.16	18.16	1,947.32
o. 2 Oil House	150.37	2	147.36		147.36
o. 3 Brooder, killing and fattening laboratory	2,204.16	2	2,160.08	639.92	2,800.00
o. 4 Mechanics, storage building and incubator cellar	3,995.89	2	3,915.97	.93	3,916.90
o. 5 Laying House	1,680.96	2	1,647.34		1,647.34
o. 6 Manure Shed	132.69	2	130.04		130.04
o. 7 Small henhouse	41.29	2	40.46		40.46
o. 8 Breeding House	1,405.62	2	1,377.51		1,377.51
o. 9 Experimental Breeding House	607.16	2	595.02		595.02
o. 10 Duck House	85.74	2	84.03		84.03
o. 11 Unit house for 200 hens	430.46	2	421.85		421.85

College Buildings (Estimated Value, 1926)—Concluded.

	Inventory at beginning of year.	Per Cent. deducted.	Value at beginning of year less deterioration.	Repairs and Improvements during year.	Total val at close of fiscal yea
No. 12 Unit house for 100 hens	392.69	2	384.84		384
Power Plant and Storage buildings including coal pocket	48,308.42	2	47,342.25	311.21	47,653
President's House	13,591.84	3	13,184.08	778.65	13,962
Rural Engineering Building	14,501.50	2	14,211.47	59.39	14,270
Sheep Barn	1,489.54	3	1,444.85	76.56	1,521
South Dormitory	42,227.26	2	41,382.71	1,635.14	43,017
Stockbridge Hall	157,632.94	2	154,480.28	511.61	154,991
Agronomy Greenhouse and Storage	4,662.43	2	4,569.18	128.91	4,698
Stockbridge House	2,055.46	5	1,952.69	40.26	1,992
Stone Chapel	28,907.74	2	28,329.59	266.77	28,596
Turbine House	17,013.92	2	16,673.64	19.31	16,692
Vegetable Plant House	5,019.69	5	4,768.71	41.78	4,810
Waiting Station	534.04	2	523.36	172.14	695
Wilder Hall	31,480.14	2	30,850.54	81.53	30,932
Young Stock Barns, including Isolation and Quarantine Barns	6,276.20	3	6,087.91	11,258.82	17,346
Stable for Cavalry Unit				228.39	13,228
Blacksmith Shop					700
Storage Barn					2,800
	1,511,314.60		1,476,621.69	32,986.03	1,526,107.

Experiment Station Buildings (Estimated Value)

	Inventory at beginning of year	Per Cent. deducted.	Cost at beginning of year less per cent. deterioration.	Repairs and improvements during year.	Total val at close of yea
Agricultural laboratory	14,064.17	2	13,782.89	73.72	13,856.
Agricultural barn	4,851.72	3	4,706.17	1,565.36	6,271.
Agricultural farmhouse	1,851.76	3	1,796.21	48.52	1,844.
Agricultural glasshouse	1,051.33	5	998.76	5.02	1,003.
Brooks house	2,772.59	5	2,633.96	96.22	2,730.
Brooks barn and sheds	1,288.69	5	1,224.26		1,224.
Brooks tobacco barn	2,850.00	5	2,707.50		2,707.
Cranberry buildings	2,508.84	5	2,383.40	5,564.11	7,947.
Entomological glasshouses	527.97	5	501.57		501.
Plant and Animal chemistry laboratory	26,767.25	2	26,231.90	349.58	26,581.
Plant and Animal Chemistry barns	6,143.06	3	5,958.77	301.96	6,260.
Plant and Animal dairy	1,705.24	3	1,654.08		1,654.
Six poultry houses	674.97	2	661.47		661.
Tillson Cottage	1,052.47	5	999.85	14.04	1,013.
Tillson Barn	991.42	5	941.85		941.
Tillson poultry houses (4) Nos. 2, 3, 4, 5	2,837.06	2	2,780.32		2,780.
Tillson Foreman's Quarters and Incubator cellar No. 1	692.06	2	678.22	6,168.54	6,846.
Tillson summer sheds (3) No. 6	418.11	5	397.20		397.
Tillson pullet brooder No. 7	1,065.82	5	1,012.53		1,012.
Tillson hen brooder No. 8	1,112.98	5	1,057.33		1,057.
	75,227.51		73,108.24	14,187.07	87,295.3

MASSACHUSETTS AGRICULTURAL COLLEGE

College Equipment (Estimated Value)

Administrative division:

Dean's Office	$1,325.
President's Office	3,325.
Registrar's Office	1,181.
Treasurer's Office	5,264.

ricultural division:	
Agricultural Engineering	9,765.29
Agronomy	9,362.77
Animal Husbandry	770.22
Dairy	24,454.15
Farm	26,043.25
Farm Livestock	47,475.00
Farm Management	1,056.03
General Agriculture	2,214.48
Poultry	10,766.40
mestic Science	4,419.98
ning Hall	39,706.01
tension	15,133.41
neral Science:	
Apiary	2,038.65
Botanical	26,540.05
Chemistry	31,589.50
Entomology	6,390.70
Mathematics	2,349.00
Microbiology	7,435.95
Physics	9,553.98
Veterinary	13,768.87
Zoology and Geology	17,705.45
aduate School	162.60
rticultural division:	
Floriculture	32,482.51
Forestry	944.05
General Horticulture	8,503.30
Grounds	2,732.80
Horticultural Manufactures	6,288.70
Landscape Gardening	7,055.60
Market Garden Field Station	4,699.84
Mount Toby Reservation	617.30
Pomology	7,593.45
Vegetable Garden	4,303.37
spital	902.25
manities Division:	
Economics and Sociology	43.23
Language and Literature	703.00
rary	148,819.24
litary	2,011.71
erating and Maintenance:	
College Supply	$768.50
Fire Apparatus	1,483.89
General Maintenance:	
Office	744.75
Carpentry and Masonry Supplies	3,956.46
Carpentry and Masonry Tools	5,624.41
Electrical Supplies	3,147.29
Electrical Tools	204.05
Electrical Commencement Supplies	533.00
Heating and Plumbing Supplies	8,723.63
Heating and Plumbing Tools	2,540.37
Painting Supplies	911.08
Painting Tools	254.00
Steam Main	6,508.66
Lighting Lines	10,394.01
nitor's Supplies	1,628.98
wer Line	13,101.65
ter Mains	12,717.22

Power Plant:	
General Equipment	92,579.
Tools	201.
Supplies	212.
Fuel	12,150.
Physical Education	1,672.
Rural Social Science:	
Agricultural Economics	2,066.
Agricultural Education	1,824.
Rural Sociology	209.
Short Course	2,779.
Textbooks	2,895.
Trophy Room	699.
Women's Dormitory	10,096.
Memorial Hall	14,523.
Freshman Agriculture	240.
Total	$762,892.

Experiment Station Equipment (Estimated Value)

Agronomy	$487.
Apiary	102.
Agricultural Economics Department	950.
Agricultural Laboratory	10,145
Botany	9,158
Cranberry Station	5,759.
Director's Office	5,349
Entomological laboratory	24,927
Entomology at Market-Garden Field Station	299.
Fertilizer and Feed Control	15,118.
P. and A. Chemistry	18,954.
Meteorological Observatory	636.
Microbiological laboratory	4,195.
Pomology	4,258.
Poultry Department	6,236.
Treasurer's Office	861.
Veterinary	4,189.
	$111,629.

Inventory—Real Estate

Land (Estimated Value)

Angus Land	$800.
Allen Place	500.
Baker Place	2,500.
Bangs Place	2,350.
Brooks Farm	11,000.
Brown Land	500.
Charmbury Place	450.
Clark Place	4,500.
College Farm	37,000.
Cranberry Land	15,500.
George Cutler Jr., Trustee	2,700.
Dickinson Land	7,850.
Harlow Farm and Orchard	3,284.
Hawley and Brown Place	675.
Kellogg Place	3,368.
Loomis Place	415.
Louisa Baker Place	5,000.
Market-Garden Field Station	21,000.

unt Toby demonstration forest	30,000.00
well Farm	2,800.00
i Creamery Place	1,000.00
'en Farm	5,000.00
ham Quarry	500.00
lson Farm	2,950.00
stcott Place	2,250.00
	$163,893.08

	Acres.
lege estate (area)	702.19
inberry Station, Wareham (area)	23.67
rket-Garden Field Station Waltham (area)	55.39
unt Toby demonstration forest (area)	755.27
le range	46.20
ham quarry	.50
Total acreage	1,583.22

Summary

nd	$163,893.08
llege buildings	1,526,107.72
llege equipment	762,892.19
periment Station buildings	87,295.31
periment Station equipment	111,629.60
Total	$2,651,817.90

Dining Hall Statement November 30, 1926

lance December 1, 1925	$13,141.56	
tal Disbursements	132,556.83	
tstanding bills November 30, 1926	5,489.52	
tal collections		$136,149.48
tstanding accounts: Nov. 30, 1926:		
Board		1,507.63
Special Service, etc.		181.10
'entory, November 30, 1926		10,260.08
lance		3,089.62
	$151,187.91	$151,187.91

Burnham Emergency Fund

	Market Value Dec. 1, 1926	Par Value	Income
bonds American Telephone & Telegraph Co. 4s @ 98	$1,960.00	$2,000.00	$80.00
bonds Power Corporation of N. Y. 6½s @ 105	2,100.00	2,000.00	130.00
United States Liberty Bond 4¼s	510.00	500.00	21.25
bond Jersey Central Power and Light Co. 5½s	990.00	500.00	
	$5,560.00	$5,000.00	$231.25
xpended balance Dec. 1, 1925	–	–	252.40
Service Company	–	–	15.00
nings from exchange of bonds	–	–	28.28
	–	–	$526.93
ursements for fiscal year ending November 30, 1926	–	–	470.13
n on hand November 30, 1926			$56.80

Library Fund

	Market Value Dec. 1, 1926	Par Value	Inc
Five bonds New York Central and Hudson River R. R. Co. 4s @ 96	$4,800.00	$5,000.00	$20
Five bonds Lake Shore & Michigan Southern Railroad Co. 4s @ 99	4,950.00	5,000.00	20
Two shares New York Central Railroad stock @ 134	268.00	200.00	1
Amherst Savings Bank deposit	175.52	175.52	
	$10,193.52	$10,375.52	$42
Disbursements for fiscal year ending Nov. 30, 1926	–	–	42

Special Funds

Endowed Labor Fund (the Gift of a Friend of the College)

Two bonds American Telephone & Telegraph Co. 4s @ 98	$1,960.00	$2,000.00	$8
Two bonds Lake Shore & Michigan Southern Railroad Co. 4s @ 99	1,980.00	2,000.00	8
One bond New York Central & Hudson River R. R. Co. 4s @ 96	960.00	1,000.00	4
One bond Indiana Hydro Electric Co. 6s @ 103	1,030.00	1,000.00	6
One bond Jersey Central Power & Light Co. 5½s	990.00	1,000.00	
Amherst Savings Bank deposit	1,143.39	1,143.39	5
	$8,063.39	$8,143.39	$31
Unexpended balance Dec. 1, 1925	–	–	12
Ohio Service Company	–	–	3
Earnings from exchange of bonds	–	–	5
	–	–	$52
Disbursements for fiscal year ending Nov. 30, 1926	–	–	7
Cash on hand November 30, 1926	–	–	$45

Whiting Street Scholarship Fund

One bond New York Central & Hudson River R. R. Co. 4s.	$960.00	$1,000.00	$4
Amherst Savings Bank deposit	771.64	771.64	3
	$1,731.64	$1,771.64	$7
Unexpended balance Dec. 1, 1925	–	–	22
	–	–	$29
Disbursements for fiscal year ending November 30, 1926	–	–	18
Cash on hand November 30, 1926	–	–	$11

Hills Fund

One United States Liberty Bond 4¼s	$1,020.00	$1,000.00	$4
One bond American Telephone & Telegraph Co. 4s	980.00	1,000.00	4
One bond New York Central & Hudson River R. R. Co. 4s	960.00	1,000.00	4
One bond New York Central R. R. debenture 4s	900.00	1,000.00	4
Three bonds Pacific Telephone & Telegraph Co. 5s @ 102	3,060.00	3,000.00	15
Boston & Albany R. R. stock 3 5/8 shares @ 172	623.50	362.00	31
Amherst Savings Bank deposit	2,572.75	2,572.75	11
Electric Securities Co. bonds 1 9/50 bonds @ 97	1,144.60	1,180.00	5
One bond Great Western Light & Power Co. 5½s	1,000.00	1,000.00	55
One bond American Gas & Electric Co. 6s	1,020.00	1,000.00	60
One bond Potomac Edison Co. 6½s	$1,050.00	$1,000.00	$65
One bond Oklahoma Gas & Electric Co. 6s	980.00	1,000.00	30
	$15,310.85	$15,114.75	$730
Unexpended balance Dec. 1, 1925	–	–	459
Penn Public Service Corp	–	–	30
Earnings from exchange of bonds	–	–	54
	–	–	$1,274
Disbursements for fiscal year ending Nov. 30, 1926	–	–	842
Cash on hand Nov. 30, 1926	–	–	$431

Mary Robinson Fund

Amherst Savings Bank deposit	$142.00	$142.00	$6.
Boston & Albany R. R. stock 3/8 shares @ 172	64.50	38.00	3.
Electric Securities Co. 41/50 bonds @ 97	795.40	820.00	41.
	$1,001.90	$1,000.00	$50.
Unexpended balance Dec. 1, 1925	–	–	291.
Cash on hand November 30, 1926	–	–	$842.

Grinnell Prize Fund

	Market Value Dec. 1, 1926	Par Value	Income
Tı shares New York Central stock @ 134	$1,340.00	$1,000.00	$70.00
Uexpended balance Dec. 1, 1925	–	–	322.64
	$1,340.00	$1,000.00	$392.64
Dbursements for prizes	–	–	50.00
Ch on hand November 30, 1926	–	–	$342.64

Gassett Scholarship

	Market Value Dec. 1, 1926	Par Value	Income
Ce bond New York Central & Hudson River Railroad ompany 4s	$960.00	$1,000.00	$40.00
Aherst Savings Bank deposit	511.64	511.64	23.23
	$1,471.64	$1,511.64	$63.23
Uexpended balance December 1, 1925	–	–	56.59
Ch on hand November 30, 1926	–		$119.82

Massachusetts Agricultural College (Investment)

	Market Value Dec. 1, 1926	Par Value	Income
Ce share New York Central Railroad stock $134 . .	$134.00	$100.00	$7.00
Uexpended balance December 1, 1925	–	–	133.14
Ch on hand November 30, 1926			$140.14

Danforth Keyes Bangs Fund

	Market Value Dec. 1, 1926	Par Value	Income
To bonds Pacific Telephone & Telegraph Company 5s at 102	$2,040.00	$2,000.00	$100.00
To bonds Union Electric Light & Power Company 5s at 100.00	2,000.00	2,000.00	100.00
To bonds American Telephone & Telegraph Company 4s t $98	1,960.00	2,000.00	80.00
Ce bond Indiana Hydro Electric Power Company 6s .	1,030.00	1,000.00	60.00
Ierest from Student Loans	–	–	136.81
	$7,030.00	$7,000.00	$476.81
Uexpended balance December 1, 1925	–	–	1,739.62
	–	–	$2,216.43
Tal loans made to Students during fiscal year 4239.50	–	–	–
Ch received on account of student loans . . 3955.25	–	–	–
Eess of loans made over accounts paid by students .	–	–	284.25
Ch on hand November 30, 1926	–	–	$1,932.18

John C. Cutter Fund

	Market Value Dec. 1, 1926	Par Value	Income
Ce bond Pacific Telephone & Telegraph Company 5s .	$1,020.00	$1,000.00	$50.00
Uexpended balance December 1, 1925	–	–	117.36
	$1,020.00	$1,000.00	$167.36
Dbursements for fiscal year ending November 30, 1926.	–	–	34.83
Ch on hand November 30, 1926	–	–	$132.53

William R. Sessions Fund

	Market Value Dec. 1, 1926	Par Value	Income
Fe shares New York Central Railroad stock at $134 .	$670.00	$500.00	$35.00
Tee United States Liberty bonds two at $1,000.00 one t $500.00 4¼s at $102	2,550.00	2,500.00	106.25
Ce bond Adirondack Light & Power Company 6s . .	1,060.00	1,000.00	60.00
Ce bond Southern Illinois Light & Power Company 6s .	1,030.00	1,000.00	60.00
	$5,310.00	$5,000.00	$261.25
Uexpended balance December 1, 1925			71.41
	–	–	$332.66
Dbursements for fiscal year ending November 30, 1926 .	–	–	100.00
Ch on hand November 30, 1926	–	–	$232.66

Alvord Dairy Scholarship Fund

	Market Value Dec. 1, 1926	Par Value	Inco
One United States Liberty Bond 4¼s	$1,020.00	$1,000.00	$42
One bond Jersey Central Light & Power Company 5½	990.00	1,000.00	–
Two bonds Great Western Power Company 5½s at $100	2,000.00	2,000.00	110
Amherst Savings Bank deposit	1,000.00	1,000.00	45
	$5,010.00	$5,000.00	$198
Unexpended balance December 1, 1925	–	–	214
	–	–	$412
Southern Illinois Light & Power	–	–	70
Earnings from exchange of bonds	–	–	102
	–	–	$584
Disbursements for fiscal year ending November 30, 1926	–	–	396
Cash on hand November 30, 1926	–	–	$188

J. W. D. French Fund

Two bonds Southern Illinois Light and Power Company 6s at $103	$2,060.00	$2,000.00	$120
Two bonds Great Western Light & Power Company 5½s at $100	2,000.00	2,000.00	110
Two bonds Jersey Central Power & Light Company 5½s at $99	1,980.00	2,000.00	–
Four bonds Oklahoma Gas & Electric Company 6s at $98	3,920.00	4,000.00	120
Amherst Savings Bank deposit	500.00	500.0	22
	$10,460.00	$10,500.00	$372
Unexpended balance December 1, 1925	–	–	297
Penn Public Service Corporation	–	–	125
Ohio Service Company	–	–	60
Earnings from exchange of bonds	–	–	332
	–	–	$1,188
Disbursements for fiscal year ending November 30, 1926	–	–	450
Cash on hand November 30, 1926	–	–	$738

F. G. Crane Fund

Five bonds Jersey Central Power and Light Company 5½s at $99	$4,950.00	$5,000.00	–
Two bonds Power Corporation of New York 6½s at $105	2,100.00	2,000.00	130
Four bonds Potomac Edison Company 6½s at $105	4,200.00	4,000.00	260
Four bonds Northern New York Utilities 6s at $105	4,200.00	4,000.00	240
Five bonds Western Power Corporation 6½s at $105	5,250.00	5,000.00	162
Five bonds Illinois Power & Light Corporation 6s at $103	5,150.00	5,000.00	300
Amherst Savings Bank	250.00	250.00	11
	$26,100.00	$25,250.00	$1,103
Unexpended balance December 1, 1925	–	–	1,157
Penn Public Service Corporation	–	–	162
Ohio Service Company	–	–	150
Earnings from exchange of bonds	–	–	335
	–	–	$2,909.
Cancelled notes and cash scholarships	–	–	1,653.
	–	–	$1,256.

Students' Loan Fund of the Massachusetts Agricultural Club

First National Bank	$500.00	$500.00	–
Total loans to students		$500.00	–
Unexpended balance Dec. 1, 1925	–	–	$16.
Interest from loans	–	–	22.
Cash on hand November 30, 1926	–	–	$38.

Summary of Balance on Hand of the Income from Funds Hel in Trust by the M. A. C.

Burnham Emergency Fund	$56.8
Library Fund	....
Endowed Labor Fund	451.1
Whiting Street scholarship Fund	117.0
Hills Fund	431.8
Mary Robinson Fund	342.6
Grinnell Prize Fund	342.6

assett scholarship	119.82
assachusetts Agricultural College Investment Fund	140.14
anforth Keyes Bangs Fund	1,932.18
hn C. Cutter Fund	132.53
illiam R. Sessions Fund	232.66
vord Dairy Scholarship Fund	188.56
D. W. French Fund	738.47
G. Crane Fund	1,256.19
assachusetts Agricultural Club Fund	38.86
	$6,521.51

I hereby certify that I have this day examined the Massachusetts gricultural College Account, as reported by the Treasurer, Fred C. enney, for the year ending November 30th, 1926. All bonds and instments are as represented in the Treasurer's Report. All disburseents are properly vouched for, and all cash balances are found to be rrect.

FRANK GERRETT,
Auditor.

HISTORY OF SPECIAL FUNDS.

Burnham Emergency Fund.—A bequest of $5,000 from T. O. H. P. urnham of Boston made without any conditions. The Trustees of the ollege have used this fund in any cases of emergency where funds were ot available. At present the fund is intact and the income only has been sed for such emergency matters as the Trustees have authorized. The und now shows an investment of $5,000.00.

Library Fund.—The library of the college at the present time contains ,000 volumes. The income from the fund raised by the alumni and hers is devoted to its increase, and additions are made from time to time the needs of the different departments require. Dec. 27, 1883, William nowlton gave $2,000; Jan. 1, 1894, Charles L. Flint gave $1,000; in 1887 lizur Smith of Lee, Mass., gave $1,315. These were the largest bequests nd now amount to $10,375.52.

Endowed Labor Fund.—Gift of a friend of the college in 1901, income which is to be used for the assistance of needy and deserving students, ,000.

Whiting Street Scholarship Fund.—Gift of Whiting Street of Northnpton, for no special purpose, but to be invested and the income used. his fund is now used exclusively for scholarship, $1,000.00.

Hills Fund.—Gift of Leonard M. and Henry F. Hills of Amherst, Mass., 1867, to establish and maintain a botanic garden, $10,000.00.

Mary Robinson Fund.—Gift of Miss Mary Robinson of Medfield, in 374, for scholarship, $1,000.00.

Grinnell Prize Fund.—Gift of Hon. Wm. Claflin, to be known as the rinnell agricultural prize, to be given to the two members of the graduing class who may pass the best oral and written examination in theory nd practice of agriculture, given in honor of George B. Grinnell of New ork, $1,000.00.

Gassett Scholarship Fund.—Gift of Henry Gassett of Boston, the inme to be used for scholarship, $1,000.00.

Massachusetts Agricultural College Investment Fund.—Investment ade by vote of trustees in 1893 to purchase one share of New York entral and Hudson River Railroad stock. The income from this fund as been allowed to accumulate, $100.00.

Danforth Keyes Bangs Fund.—Gift of Louisa A. Baker of Amherst, ass., April 14, 1909, the income thereof to be used annually in aiding oor, industrious, and deserving students to obtain an education in said ollege, $6,000.00.

John C. Cutter Fund.—Gift of Dr. John C. Cutter of Worcester, Mass., an alumnus of the college, who died in August, 1909, to be invested by the trustees and the income to be annually used for the purchase of books on hygiene, $1,000.00.

Alvord Dairy Scholarship Fund.—Gift of Henry E. Alvord, who was the first instructor in military tactics, 1869-71, and a professor of agriculture, 1885-87, at this institution. The income of this fund is to be applied to the support of any worthy student of said college, graduate or postgraduate, who may be making a specialty of the study of the dairy husbandry (broadly considered) with the intention of becoming an investigator, teacher, or special practitioner in connection with the dairy industry, provided that no benefits arising from such fund shall at any time be applied to any person who then uses tobacco in any form or fermented or spirituous beverages, or is known to have done so within one year next preceding, $4,000.00.

William R. Sessions Fund.—In accordance with the request of my deceased wife, Clara Markham Sessions, made in her last will, I bequeath to the trustees of the Massachusetts Agricultural College, Amherst, Mass., the sum of $5,000, it being the amount received by me from the estate of the said Clara Markham Sessions. The said $5,000 to be kept by the said trustees a perpetual fund, the income from which shall be for the use of the Massachusetts Agricultural College; and according to the further request of my deceased wife, made in her last will, this is to be known as the William R. Sessions fund, and is to be a memorial of William R. Sessions; and it is my special request that the said trustees shall make record of the fact that this fund came from the estate of my deceased wife, Clara Markham Sessions, in accordance with her request made in her last will, $5,000.00.

J. D. W. French.—Gift of the Bay State Agricultural Society of Boston, Mass. This fund to be known as the J. D. W. French fund, and the Trustees of the Massachusetts Agricultural College are to use the income of this fund where it will do the greatest good, in the interest of Dairying and its allies, also in Forestry, as scholarships, loans, or prizes; especially, however, to help pay the expenses of the judging teams to the National Dairy Show and to the National Livestock Show, $10,000.00.

Frederick G. Crane Fund.—Gift of Frederick G. Crane of Dalton, Massachusetts. The income of this fund is to be expended by the Trustees of the Massachusetts Agricultural College in aid of worthy undergraduate students of limited financial resources at the college, preference being given to residents of Berkshire County; such payments are to be known as the Frederick G. Crane Scholarships, $25,000.00.

Massachusetts Agricultural College Fund.—The Massachusetts Agricultural Club gave $500 to be used as a scholarship fund to the Massachusetts Agricultural College to help out deserving students there, who intended seriously to go into agriculture, interest on loans not to be charged until after graduation, $500.00.

Charles A. Gleason Fund.—The gift of Charles A. Gleason of North Brookfield, Mass., a trustee of the college from 1889 to his death, September 29, 1925. "A clean record of noble deeds." This fund is to be used as the Trustees of the College shall direct. $5,000.00.

Total of special funds, $90,575.52.

FRED C. KENNEY,
Treasurer

UBLIC DOCUMENT No. 31

THE M. A. C. BULLETIN
AMHERST, MASSACHUSETTS

VOLUME XIX JANUARY, 1927 NUMBER 1

PUBLISHED EIGHT TIMES A YEAR BY THE MASSACHUSETTS AGRICULTURAL COLLEGE: JAN., FEB., MARCH, MAY, JUNE, SEPT., OCT., NOV. ENTERED AT THE POST OFFICE, AMHERST, MASS., AS SECOND CLASS MATTER

THE SIXTY-FOURTH ANNUAL REPORT OF THE MASSACHUSETTS AGRICULTURAL COLLEGE

PART II. — CATALOGUE OF THE COLLEGE FOR 1926-1927

Publication of this Document approved by the Commission on Administration and Finance

5M-9-'26 No. 6376.

The Commonwealth of Massachusetts

Massachusetts Agricultural College,
Amherst, November 30, 1926.

To the Commissioner of Education.

Sir: — On behalf of the trustees of the Massachusetts Agricultural College have the honor to transmit herewith Part II of the sixty-fourth annual report the trustees for the fiscal year ended November 30, 1926, this being the catalog of the college.

Respectfully yours,

EDWARD M. LEWIS,
President.

CONTENTS.

Without excluding other scientific and classical studies, and including milita tactics, to teach such branches of learning as are related to agriculture and mechar arts in such manner as the legislatures of the states may respectively prescribe, order to promote the liberal and practical education of the industrial classes in t several pursuits and professions of life. — *Act of Congress, July 2, 1862.*

The College Charter. — "The leading object of the college shall be to tea subjects relating to agriculture and the mechanic arts, so as to promote liberal a practical education. Its curriculum may include other scientific and classic studies and shall include military tactics." — *From Chapter 75 of the General La of Massachusetts.*

This issue of the catalogue represents the status of the college for the curre college year, with provisional announcement of courses of study and other matte for the year to follow. When deemed necessary, additional announcements a made in a supplementary bulletin, published in the spring.

The college reserves, for itself and its departments, the right to withdraw change the announcements made in its catalogue.

Calendar.

1926–1927.

1926.

September 13, Monday	Fall term begins for Freshmen
September 15, Wednesday	Fall term begins for all except Freshmen
October 12, Tuesday	Holiday — Columbus Day
November 24–29, Wednesday, 12 M.–Monday, 7.30 A.M.	Thanksgiving Recess
December 18, Saturday, 12 M.	Fall term ends

1927.

January 3, Monday, 7.30 A.M.	Winter term begins
February 22, Tuesday	Holiday, Washington's Birthday
March 19, Saturday, 12 M.	Winter term ends
March 28, Monday, 7.30 A.M.	Spring term begins
April 19, Tuesday	Holiday, Patriot's Day
May 31, Tuesday	Holiday, Observance of Memorial Day
June 10–13, Friday–Monday	Commencement
June 16–18, Thursday–Saturday	Entrance Examinations
September 7–10, Wednesday–Saturday	Entrance Examinations
September 12, Monday	Fall term begins for Freshmen
September 14, Wednesday	Fall term begins for all except Freshmen
October 12, Wednesday	Holiday, Columbus Day
November 23–28, Wednesday, 12 M.–Monday, 7.30 A.M.	Thanksgiving Recess
December 17, Saturday, 12 M.	Fall term ends

1928.

January 3, Tuesday, 7.30 A.M.	Winter term begins

Massachusetts Agricultural College.

History. — The Massachusetts Agricultural College was organized under t national land grant act of 1862. This legislation is also known as the Morrill a, the original bill having been framed by Justin Smith Morrill, Senator from Vermo, and its final enactment secured under his leadership. It provided that public lan be assigned to the several States and territories, the funds from the sale of whi were to be used to establish and maintain colleges of agriculture and mecha arts. The Massachusetts Agricultural College was among the first of these insti-tions established. When this act was passed the Massachusetts Institute of Tec-nology was already organized, and the State of Massachusetts decided that t instruction in the mechanic arts should be at the Institute, and that the new ins-tution should confine its work to agriculture. On this account the Massachuse Agricultural College has the unique distinction of being the only separate agric-tural college in the country.

In 1863 the State of Massachusetts accepted the provisions of the Morrill a and incorporated the Agricultural College. The location at Amherst was select only after long and careful study by the original Board of Trustees. The coll was formally opened to students on the 2d of October, 1867, with a faculty of fo teachers and with four wooden buildings.

The Massachusetts Legislature has granted money for the erection of practica all of the buildings now on the grounds. In view of the fact that the annual inco from the original endowment has been only a few thousand dollars, it has be necessary for the State to assume large responsibility for the current expenses the institution.

Organization. — The college is a State institution, serving in the Departme of Education and as such is subject to the laws governing and the rules applyi to all State departments and institutions. The work of the college is directed by board of eighteen trustees. Four of these are ex-officio members, — the Govern of the State, the Commissioner of Education, the Commissioner of Agriculture a the President of the college. The other fourteen members are appointed by t Governor, two each year, for terms of seven years. The immediate control of t institution is vested in the President of the college. The administrative office, having supervision of the various departments of activity, are directly responsi to the President.

In carrying out its purpose the college has organized three distinct yet correlat types of work, — namely, research, resident instruction and extension service.

Research. — In 1882 Massachusetts provided for the establishment of an ag-cultural experiment station. This station, though on the college grounds and su-ported by the State, was without organic connection with the college. Under act of Congress, passed in 1887, an agricultural experiment station was establish and supported as a department of the college. For a time, therefore, Massach-setts had two experiment stations at the college. In 1895 these were combine and the station reorganized as a department of the college. It is now supported funds from both the State and the Federal government. In 1906 the Fede government largely increased its support on condition that the money thus pr vided should be used only for research. The station now receives about two-thir of its support from the State.

The station is under the direct supervision of the Board of Trustees; the chi officer is the director, who is responsible to the President. It is organized into ımber of departments, all co-operating toward the betterment of agriculture. In ost cases the heads of these departments are heads of corresponding departments the college.

Resident Instruction. — The college offers an education at a nominal tuition e of $20 per term to any student who is a resident of Massachusetts and who eets the requirements for admission. Women are admitted on the same basis are men. Students who are not residents of Massachusetts are required to pay tuition fee of $180 per year. The chief aim of the institution, through its resi-nt instruction, is to prepare men and women for the agricultural vocations. he term "agricultural vocations" is here used in its broadest sense. Courses e offered which give efficient training in various agricultural pursuits, such as neral farming, dairying, management of estates, poultry husbandry, fruit owing, market gardening, floriculture, landscape gardening and forestry. Stu-nts are also trained for investigation in many sciences underlying the great ricultural industry, for teaching in agricultural colleges and high schools, and r scientific work in chemistry, entomology, botany and microbiology. Com-ehensive courses in home making are now available for women.

Though training for the agricultural vocations is thus the chief concern of the llege, students should find the course one that trains them admirably for pur-its in which the sciences are an essential preparation. The course of study aims so to combine an adequate general education with specialized technical and actical training.

Four-year Courses. — Twenty-nine teaching departments offer instruction in riculture, horticulture, sciences, the humanities, rural social science and home aking. A system of major courses permits the student to elect major work in ıe of sixteen departments, and to specialize in it and allied subjects for a period two years. The degree of bachelor of science is granted on the satisfactory mpletion of the four years' work of collegiate grade.

Short Courses. — In order to extend the advantages of the institution to those en and women who cannot or do not care to pursue the four-year course, various ort courses are offered. Chief among these are a two-year course in practical riculture, a summer school of agriculture and country life, and a winter school agriculture.

Graduate School. — The graduate school is organized to provide the neces-ry training for scientific leadership in agriculture and allied sciences. The de-ees of master of agriculture, master of landscape architecture, master of science, octor of agriculture and doctor of philosophy may be earned upon the completion satisfactory study, research and thesis.

The Extension Service. — The Extension Service is the organized educational gency of the college which serves the people of the State other than resident udents. Its function is to make available to Massachusetts citizens useful and actical information in agriculture and home economics which is developed by ıe experiment station or the United States Department of Agriculture, and which taught by the college to resident students. It is the recognized agency of the nited States Department of Agriculture for teaching those who cannot attend llege, and is a cooperative effort by the Department of Agriculture, the Massa-usetts Agricultural College, and the County Extension Services.

The Extension Service uses many methods of work, among which are the fol-wing:

Demonstrations.
Publications.
Correspondence Courses.
Lectures.
Exhibits.
Extension Schools.
Leader-training Groups.
Boys' and Girls' Clubs in Agriculture and Home Economics.
Agricultural News Letters.

Literature descriptive of these various services will be mailed on request. Info- mation may also be secured from the county agricultural agents at the followi- addresses:

Berkshire County Extension Service, Howard Block, Pittsfield, Mass.
Bristol County Agricultural School, Segreganset, Mass.
Cape Cod Extension Service, Barnstable, Mass.
Essex County Agricultural School, Hathorne, Mass.
Franklin County Extension Service, Sheldon Block, Greenfield, Mass.
Hampden County Improvement League, 719 Bridge St., West Springfield, Ma-
Hampshire County Extension Service, 59 Main St., Northampton, Mass.
Middlesex County Extension Service, 740 Main St., Waltham, Mass.
Norfolk County Agricultural School, Walpole, Mass.
Plymouth County Extension Service 106 Main St., Brockton, Mass.
Worcester County Extension Service, 19 Court St., Worcester, Mass.

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[1] Temporary.

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1926-1927.

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A. Application for Admission.

Correspondence concerning admission should be addressed to the ean's office.

Every applicant for admission to the college must be at least sixteen years old, nd must present to the Dean proper testimonials of character, which, whenever ossible, should come from the principal of the school at which the applicant as prepared for college. Candidates who desire to present themselves for examiation in any subjects must make application to the college for such privilege at ast one month before the date of the examination. Blanks for such application ay be obtained by addressing the Dean of the college. All entrance credenals must be in the hands of the Dean before the applicant can matriculate.

B. Modes of Admission.

Students are admitted to the freshman class either upon certificate or upon xamination. No *diploma* from a secondary school will be accepted.

Certificates. — The Massachusetts Agricultural College is affiliated with the ew England College Entrance Certificate Board. Therefore certificates of admison will be accepted from schools approved by the Board. Certificates of admison will also be accepted from any Massachusetts school listed as class "A" by e State Department of Education, but not included in the approved lists of e New England College Entrance Certificate Board. Principals of schools in ew England who desire the certificate privilege should address the secretary of e Board, Professor Frank W. Nicolson, Wesleyan University, Middletown, onn. Certificates from schools outside of New England may be received if those hools are on the approved list of the leading colleges of the section in which the hool in question is located.

The credentials of the Board of Regents of the State of New York are accepted s satisfying the entrance requirements of this college when offered subject for ibject.

Certificates in order to be accepted must present in the prescribed and restrictive ective groups at least three of the necessary fourteen and one-half credits. It is be understood, however, that responsibility for certification in either elementary rench, elementary German, English 1 or English 2, Latin A, Greek A or algebra ust be assumed by one school, if the candidate has received his preparation in ny one subject named above in more than one school. Subjects lacking on cerficate must be made up at the time of the examinations for admission. Condiions to the amount of two units will be allowed.

Special Certificate Arrangement for Students from Agricultural chools. — Superior graduates of Vocational Schools of Agriculture in Massahusetts and Vocational Agricultural Departments in Massachusetts High Schools ay be accepted for the Degree of Vocational Agriculture provided: —

(*a*) they are unqualifiedly recommended by the Vocational Division of the epartment of Education as bona fide Vocational Graduates with superior ank; and

(b) that they can present at least 14½ units of certified entrance credits approved as to quality and quantity by the State Department of Vocationa Education.

Blank forms for certification — sent to principals or school superintendent only — may be obtained on application to the Dean of the college.

Examinations. — The examination in each subject may be oral or written, o both. The standard required for passing an examination for admission is 60 pe cent.

Entrance examination for admission to the Massachusetts Agricultural Colleg will be held at the following centers: —

In June	Amherst, Stockbridge Hall, room 114. Cambridge, Massachusetts Institute of Technology. Worcester, Worcester Polytechnic Institute.
In September	Amherst, Stockbridge Hall, room 114.

Please note that September examinations are held in Amherst only

Schedule for Entrance Examinations June 16–18, 1927.

First Day.

8.30 A.M.	Algebra.
10.30 A.M.	Chemistry.
2.00 P.M.	History (ancient, medieval and modern, English, general, Unite States and Civics).

Second Day.

8.30 A.M.	English 1 and 2.
11.30 A.M.	Botany.
2.00 P.M.	Plane Geometry.
3.30 P.M.	Physics.

Third Day.

8.30 A.M.	French, German, Spanish, required and elective.
1.00 P.M.	Latin, elementary, intermediate and advanced, and all one-ha credit electives, except those already noted.

Schedule for Entrance Examinations September 7–10, 1927.

First Day.

2.15–5.00 P.M.	Greek, elementary and intermediate.

Second Day.

8.30 A.M.	Algebra.
10.30 A.M.	Chemistry.
2.00 P.M.	History (ancient, medieval and modern, English, general, Unite States and Civics).

Third Day.

8.30 A.M.	English 1 and 2.
11.30 A.M.	Botany.
2.00 P.M.	Plane Geometry.
3.30 P.M.	Physics.

Fourth Day.

8.30 A.M.	French, German, Spanish, required and elective.
1.00 P.M.	Latin, elementary, intermediate and advanced, and all one-ha credit electives, except those already noted.

C. Requirements for Admission.

The requirements for admission are based on the completion of a four-year high school course, or its equivalent, and are stated in terms of units. The term unit means the equivalent of at least four recitations a week for a school year.

Fourteen and one-half units must be offered for admission in accordance with the entrance requirements as stated below. Entrance credits gained either by certificate or by examination will hold good for one year.

Entrance Requirements.

1. *Prescribed.* — The following units are prescribed: —

English 1	2
English 2	1
A foreign language	2
Algebra	$1\frac{1}{2}$
Plane geometry	1
	$7\frac{1}{2}$

2. *Restricted Electives.* — Three units to be selected from —

Science	1, 2 or 3
History (American history and civics included)	1, 2 or 3
A second foreign language	2 or 3
Additional work, in first foreign language	1 or 2

3. *Free Margin.* — Free margin of four units to consist of any substantial work (including agriculture, general science and a fourth year of English) for which credit of not less than one-half unit earned in one year is given toward a secondary school diploma. Units presented in the free margin group may be offered only by certificate.

4. One unit of history must be offered in either the restricted electives or the free margin.

5. If elementary algebra and plane geometry are counted as three units, the total requirement will be fifteen units.

6. Both the credits under the prescribed group and the restricted elective group must be presented either by certificate from an approved school or by examination, or by a combination of both.

The following is a list of subjects in which the entrance credits must be offered in the prescribed and restricted elective groups: —

Mathematics and Science.

Botany[1]	$\frac{1}{2}$ or 1
Chemistry[1]	1
Algebra	$1\frac{1}{2}$
Plane geometry	1
Solid geometry	$\frac{1}{2}$
Trigonometry	$\frac{1}{2}$
Physics[1]	1
Geology	$\frac{1}{2}$
Physical geography	$\frac{1}{2}$
Physiology	$\frac{1}{2}$
Zoölogy[1]	$\frac{1}{2}$

[1] Note-Books. — The keeping of a note-book is required as part of the preparation in those subjects indicated. Candidates presenting themselves for examination in such subjects must present at the same time a statement signed by the Principal to the effect that a satisfactory note-book has been kept by the candidate.

History.

Ancient	1
Medieval and modern	1
English	1
General	1
United States and civics	1

English.

English 1	2
English 2	1

Foreign Language.

Elementary French	2
Elementary German	2
Elementary Spanish	2
Elementary Latin	2
Elementary Greek[1]	2
Intermediate French	1
Intermediate German	1
Intermediate Spanish	1
Intermediate Latin	1
Intermediate Greek[1]	1
Advanced French	1
Advanced German	1
Advanced Spanish	1
Advanced Latin	1

No applicant deficient in both algebra and plane geometry will be admitted.

D. Statement of Preparation Required for Admission.

Agriculture. — Entrance credit in agriculture is granted on the following basis: —

I. The Massachusetts Agricultural College accepts a maximum of four credits in agriculture from any secondary or county agricultural high school in Massachusetts offering work in that subject, provided evidence of such work having been done is submitted on a principal's statement, as is indicated in the "free margin" group.

II. In high schools organizing agricultural club work under the supervision and rules of the junior extension service of the college, one credit is granted for each full year of work performed under the following plan: —

Work of the Winter Term. — (*a*) The study of textbooks such as are suitable for secondary school instruction in agriculture.

(*b*) Course of Study: A general outline of suggested topics for study.

(*c*) Visits by a representative of the Massachusetts Agricultural College for observation, counsel and advice in regard to kind and amount of work being done in agriculture.

(*d*) Formation of an agricultural club with officers from among its own members, meeting once a month under local supervision of some one authorized to act for the school authorities.

Work of the Spring Term. — Same in general form as winter term.

Work of the Summer Term. — An approved project conforming to the rules of some one or more of the agricultural clubs of the junior extension service of the Massachusetts Agricultural College.

Work of the Fall Term. — (*a*) An exhibit of work.

(*b*) Reports and story of achievement submitted to the junior extension service of the college.

Botany. — For one unit of credit in botany, the work outlined in the statement of requirements issued by the College Entrance Examination Board, or its equiva-

[1] Examination in September only.

lent, will be accepted. This work should occupy one school year and include laboratory and supplementary textbook study. For one-half unit of credit, work that covers the same ground but occupies half the time required for a full unit of credit will be accepted. These requirements are met by such texts as Stevens' "Introduction to Botany" and Bergen & Davis' "Principles of Botany." A note-book, containing neat, accurate drawings and descriptive records forms part of the requirement for either the half-unit or the one-unit credit, and this note-book must be presented by all applicants for admission upon examination in this subject. The careful preparation of an herbarium is recommended to all prospective students of this college, although the herbarium is not required.

Chemistry. — The entrance examination in chemistry will cover the work outlined by the College Entrance Examination Board as preparatory for college entrance. In general, this consists of a year of high school chemistry from any standard textbook, with laboratory work on the properties of the common elements and their simpler compounds. No particular work is prescribed. The keeping of a note-book is required.

Students who do not take chemistry in the preparatory school begin the subject in college, and are required to do extra work during the first two terms, as outlined under chemistry, courses 1 and 2, pages 61 and 62.

Mathematics. — (a) *Required.* — Algebra: The four fundamental operations for rational algebraic expressions; factoring, determination of highest common factor and lowest common multiple by factoring; fractions, including complex fractions; ratio and proportion; linear equations, both numerical and literal, containing one or more unknown quantities; problems depending on linear equations; radicals, including the extraction of the square root of polynomials and numbers; exponents, including the fractional and negative; quadratic equations, both numerical and literal; simple cases of equations with one or more unknown quantities that can be solved by the methods of linear or quadratic equations; problems depending upon quadratic equations; the binomial theorem for positive integral exponents, the formulas for the *n*th term and the sum of the terms of arithmetic and geometric progressions, with applications.

Plane Geometry: The usual theorems and constructions of good textbooks, including the general properties of plane rectilinear figures; the circle and the measurement of angles; similar polygons; areas; regular polygons and the measurement of the circle; the solution of numerous original exercises, including loci problems; applications to the mensuration of lines and plane surfaces.

(b) *Elective.* — Solid Geometry: The usual theorems and constructions of good textbooks, including the relations of planes and lines in space; the properties and measurement of prisms, pyramids, cylinders and cones; the sphere and spherical triangle; the solution of numerous original exercises, including loci problems; applications to the mensuration of surfaces and solids.

Plane Trigonometry: A knowledge of the definitions and relations of trigonometric functions and of circular measurements and angles; proofs of the principal formulas and the application of these formulas to the transformation of the trigonometric functions; solution of trigonometric equations, the theory and use of logarithms, and the solution of right and oblique triangles.

Physics. — To satisfy the entrance requirement in physics, the equivalent of at least one unit of work is required. This work must consist of both classroom work and laboratory practice. The work covered in the class-room should be equal to that outlined in Hall & Bergen's "Textbook of Physics" or Millikan & Gale; the laboratory work should represent at least thirty-five experiments involving careful measurements, with accurate recording of each in laboratory note-book. This note-book, certified by the instructor in the subject, must be submitted by each candidate presenting himself for examination in physics; credit for passing the subject will be given on laboratory notes and on the examination submitted. Candidates entering on certificate will not be required to present note-books, but the principal's certification must cover laboratory as well as class-room work.

Physiology. — Hough & Sedgwick's "The Human Mechanism;" Martin's "The Human Body; Briefer Course."

Zoölogy, Physical Geography, Geology. — The following suggestions are made concerning preparation for admission in the subjects named above: —

For physiography, Davis' "Elementary Physical Geography;" Gilbert & Brigham's "Introduction to Physical Geography." For zoölogy, textbooks entitled "Animals" or "Animal Studies," by Jordan, Kellogg and Heath; Linville & Kelley's "A Textbook in General Zoölogy." For geology, A. P. Brigham's "A Textbook of Geology" or Tarr's "Elementary Geology."

Applicants for examination in zoölogy are *required* to present certified laboratory note-books; applicants for examination in the other subjects are *advised* to present note-books, if laboratory work has been done. Good note-books may be given credit for entrance. Examination in these subjects will be general, in recognition of the different methods of conducting courses; but students will be examined on the basis of the most thorough secondary school courses.

History. — The required unit must be offered in either ancient history, medieval and modern history, English history, general history, or United States history and civics. Either one, two or three elective units in any of the historical subjects here named may be offered, provided that no unit be offered in the same subject in which the required unit has been offered.

Preparation in history will be satisfactory if made in accordance with the recommendations of the committee of seven of the American Historical Association, as outlined by the College Entrance Examination Board. The examination will require comparisons and the use of judgment by the candidate rather than the mere use of memory, and it will presuppose the use of good textbooks, collateral reading and practice in written work. Geographical knowledge may be tested by requiring the location of places and movements on outline maps.

To indicate in a general way the character of the textbook work expected, the texts of the following authors are suggested: Botsford, Morey or Myers, in ancient history (to 814 A.D.); Adams, West or Myers, in medieval history; Montgomery, Larned or Cheyney, in English history; Myers or Fisher, in general history; Fiske, together with MacLaughlin or Montgomery, in United States history and civics.

English. — The study of English in school has two objectives of equal importance: first, the ability to use the English language, in both speech and writing, clearly, correctly and effectively; and, second, the ability to read English literature with understanding and appreciation.

(1) *Grammar and Composition* (Two Units). — The first objective makes necessary a rigorous and reiterated instruction in grammar and composition, with special emphasis upon: spelling, sentence structure, punctuation and paragraph development. College freshmen are found deficient particularly in these fundamental phases of rhetoric.

(2) *Literature* (One Unit). — The second objective is sought by means of two lists of books, designated as *Books for Reading* and *Books for Study*, from which may be selected material for a progressive, four-year course in literature. The student should be trained to read aloud, to memorize significant passages, to associate the books with their historic background and to have well in hand both content and structure. He should be prepared for general examination on the former list and detailed examination on the latter. However accurate in subject matter, no paper will be considered satisfactory if seriously defective in punctuation, spelling or other essentials of good usage.

Lists of Books for 1926–1928.

1. *Books for Reading.*

From each group two selections are to be made, except that for any book in Group V a book from any other may be substituted.

Group I.

Cooper: "The Last of the Mohicans."
Dickens: "A Tale of Two Cities."
George Eliot: "Silas Marner."
Scott: "Ivanhoe" or "Quentin Durward."
Stevenson: "Treasure Island" or "Kidnapped."
Hawthorne: "The House of the Seven Gables."

Group II.

Shakespeare: "The Merchant of Venice," "Julius Caesar," "King Henry V," "As You Like It," "The Tempest."

Group III.

Scott: "The Lady of the Lake."
Coleridge: "The Ancient Mariner;" and Arnold: "Sohrab and Rustum."
A collection of representative verse, narrative and lyric.
Tennyson: "Idylls of the King" (any four).
"The Æneid" or "The Odyssey" in a translation of recognized excellence, with the omission, if desired, of Books I-V, XV, and XVI of "The Odyssey."
Longfellow: "Tales of a Wayside Inn."

Group IV.

The "Old Testament" (the chief narrative episodes in Genesis, Exodus, Joshua, Judges, Samuel, Kings and Daniel, together with the books of Ruth and Esther).
Irving: "The Sketch Book" (about 175 pages).
Addison and Steele: "The Sir Roger de Coverley Papers."
Macaulay: "Lord Clive" or "History of England," Chapter III.
Franklin: "Autobiography."
Emerson: "Self-Reliance and Manners."

Group V.

A modern novel.
A collection of short stories (about 150 pages).
A collection of contemporary verse (about 150 pages).
A collection of scientific writings (about 150 pages).
A collection of prose writings on matters of current interest (about 150 pages).
A selection of modern plays (about 150 pages).

All selections from this group should be works of recognized excellence.

2. Books for Study.

One selection is to be made from each of Groups I and II, and two from Group III.

Group I.

Shakespeare: "Macbeth," "Hamlet."

Group II.

Milton: "L'Allegro," "Il Penseroso," and either "Comus" or "Lycidas."
Browning: "Cavalier Tunes," "The Lost Leader," "How They Brought the Good News from Ghent to Aix," "Home Thoughts from Abroad," "Home Thoughts from the Sea," "Incident of the French Camp," "Hervé Riel," "Pheidippides," "My Last Duchess," "Up at a Villa — Down in the City," "The Italian in England," "The Patriot," "The Pied Piper," "De Gustibus," "Instans Tyrannus," "One Word More."

Group III.

Burke: "Speech on Conciliation with America."
Macaulay: "Life of Johnson."
Arnold: "Wordsworth," with a brief selection from Wordsworth's Poems.
Lowell: "On a Certain Condescension in Foreigners," and "Shakespeare Once More."

French. — Elementary: The necessary preparation for this examination is stated in the description of the two-year course in elementary French recommended by the Modern Language Association, contained in the definition of requirements of the College Entrance Examination Board.

Third and fourth year French (elective subjects for admission). — For a third credit unit in French as an elective subject for entrance, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in French will be given unless the candidate has presented elementary French on certificate, or has written the examination in elementary French.

No examination for a fourth credit in French will be given unless the candidate has presented both elementary and intermediate French upon certificate, or has written the examination in both elementary and intermediate French.

German. — Elementary: The entrance requirements in German conform to those of the College Entrance Examination Board for elementary German (the standard two-year requirements).

Third and fourth year German (elective subjects for admission). — For a third credit unit in German as an elective subject for entrance, when required units have been offered in German, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in German will be given unless the candidate has presented elementary German upon certificate, or has written the examination in elementary German.

No examination for a fourth credit in German will be given unless the candidate has presented both elementary and intermediate German upon certificate, or has written the examination for both elementary and intermediate German.

Spanish. — Elementary: The necessary preparation for this examination is stated in the description of the two-year course in elementary Spanish recommended by the Modern Language Association, contained in the definition of requirements of the College Entrance Examination Board.

Third and fourth year Spanish (elective subjects for admission). — For a third credit unit in Spanish as an elective subject for entrance, the work heretofore described by the College Entrance Examination Board as "intermediate" is expected. For a fourth credit unit, the work described as "advanced" is expected.

No examination for a third unit in Spanish will be given unless the candidate has presented elementary Spanish on certificate, or has written the examination in elementary Spanish.

No examination for a fourth credit in Spanish will be given unless the candidate has presented both elementary and intermediate Spanish upon certificate, or has written the examination in both elementary and intermediate Spanish.

Greek. — *Elementary.* — Greek grammar and composition: Translation into Greek of short sentences illustrating common principles of syntax.

The examination in grammar and prose composition will be based on the first four books of Xenophon's "Anabasis."

Intermediate. — Homer's "Iliad," Books I and II (omitting Book II, 494 to end), and the Homeric forms, constructions, idioms and prosody.

Prose composition, consisting of continuous prose based on Xenophon, and other Attic prose of similar difficulty.

Translation of passages of Homer at sight.

The examinations in Greek, elementary and intermediate, will be given in September only.

Latin. — *Elementary.* — Two credit units will be allowed if satisfactory proficiency is shown (including grammar) in (*a*) the translation of a passage or passages taken from Cæsar's "Gallic War," covering at least four books, and (*b*) the translation of passages of Latin prose at sight.

Intermediate. — Cicero (third oration "Against Catiline" and the orations "For Archias" and "For Marcellus") and sight translation of prose.

Advanced. — Vergil (Æneid, II, III and VI) and sight translation of poetry.

E. Admission to Advanced Standing.

Candidates for admission to advanced standing, in addition to meeting the regular entrance requirements, must also pass examinations in those subjects already purued by the class they desire to enter. To meet this requirement, a student transerring to this college from another college or university of recognized standing nust present the following credentials: —

1. A letter of honorable dismissal from the institution with which he has been :onnected.

2. A statement or certificate of his entrance record.

3. A statement from the proper officer showing a complete record of his work vhile in attendance.

4. A marked catalogue showing the courses pursued.

5. A statement from the proper officer, giving the total number of credits required or graduation by the institution from which the applicant is transferring, and, of his total, the number that the applicant has satisfactorily completed at the time of transfer.

These credentials should be presented to the Dean. Applications will be udged wholly on their merits and the college may prescribe additional tests before accepting applicants or determining the standing to be granted them.

F. Other Information about Entrance.

1. The privileges of the college may be withdrawn from any student at any time f such action is deemed advisable. (It is immaterial whether the pupil has entered by certificate or by examination.)

2. The examination in each subject may be either oral or written, or both. The standard required for passing an entrance examination is 60 per cent.

3. To matriculate, candidates must offer twelve and one-half of the fourteen and one-half units required for admission, and will be conditioned in those subjects not passed. At least five and one-half credits must be in the prescribed group. No candidate deficient in both algebra and plane geometry will be admitted.

4. Examinations for the removal of entrance conditions will be held during the first week of the second term.

5. Credits for entrance requirements, whether gained by certificate or by examination, will hold good for one year.

6. Examinations in part of the subjects required for entrance may be taken one year before entering college.

7. For information concerning expenses, scholarships, etc., see "General Information."

8. For information concerning admission to non-collegiate courses, see page 122.

9. Application for admission as a "Special Student" should be made to the Dean.

10. All entrance conditions must be removed before a student is permitted to enter upon the work of the sophomore year.

Courses of Instruction.

FRESHMAN YEAR.

Table of Freshman Subjects.

[Groups A and B of each term are required of all Freshman men: groups A and C of all Freshman wome[n]. For details, see the following tables of the first, second, and third terms, and the description of the course[s].

First Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hou[rs] per Week.
Required Groups.			
Group A; for men and women:			
Agriculture 1	3	-	3
Chemistry 1	3	4	5
or			
Chemistry 4	2	4	4
English 1	3	-	3
Language 1 or 4 (French or German)	3	-	3
Mathematics 1 (Algebra)	4	-	4
Group B; for men:			
Military 1 (or Physical Education 7)	-	3	2
Physical Education 1	1	-	1
Physical Education 2	-	2	1
Group C; for women:			
Rural Home Life 1	2	-	2
Physical Education 4	-	3	2

Second Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hou[rs] per Week.
Required Groups.			
Group A; for men and women:			
Agriculture 2	3	-	3
Chemistry 2	3	4	5
or			
Chemistry 5	2	4	4
English 2	3	-	3
Language 2 or 5 (French or German)	3	-	3
Mathematics 2 (Higher Algebra)	3	-	3
or			
Mathematics 3 (Solid Geometry)	3	-	3
Mathematics 4 (Mensuration)	2	-	2
Group B; for men:			
Military 2 (or Physical Education 8)	-	3	2
Group C; for women:			
Physical Education 5	-	3	2

Third Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
;roup A; for men and women:			
Agriculture 3	3	–	3
Botany 3	2	4	4
English 3	3	–	3
Language 3 or 6 (French or German)	3	–	3
Mathematics 5 (Trig.)	3	–	3
;roup B; for men:			
Military 3 (or Physical Education 9)	–	3	2
Physical Education 3	–	2	1
;roup C; for women:			
Physical Education 6	–	3	2
Agriculture 6	2	–	2

SOPHOMORE YEAR.

Table of Sophomore Subjects.

[Groups A and B of each term are required of all Sophomore men; groups A and C, of all Sophomore omen. In addition one of the "Divisional Elective Groups" is to be elected as a unit by each Sophomore. or details, see the following tables of the first, second, and third terms, and the description of the courses.]

First Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
;roup A; for men and women:			
English 25	2	–	2
English 28	1	–	1
Physics 25	3	2	4
Zoölogy 26	2	4	4
;roup B; for men:			
Military 25 (or Physical Education 30)	–	3	2
Physical Education 25	–	2	1
;roup C; for women:			
Physical Education 27	–	5	3
Divisional Elective Groups.			
,griculture:			
Agronomy 25	2	4	4
Animal Husbandry 25	2	2	3
Iorticulture:			
Entomology 26	4	–	4
Horticulture 25	1	4	3
,andscape Gardening:			
Drawing 25	–	8	4
Horticulture 25	1	4	3
cience:			
Entomology 26	4	–	4
Modern Language (French or German)	3	–	3
Rural Social Science:			
Economics 25	5	–	5
Elective (optional)	–	–	3
Rural Home Life:			
Microbiology 30	–	6	3
Rural Home Life 28	1	6	4

Second Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Ho[urs] per Wee[k]
Required Groups.			
Group A; for men and women:			
Botany 25	1	4	3
English 26	2	–	2
English 29	1	–	1
Group B; for men:			
Military 26 (or Physical Education 31)	–	3	2
Group C; for women:			
Physical Education 28	–	3	2
Divisional Elective Groups.			
Agriculture:			
Animal Husbandry 26	2	2	3
Chemistry 30	3	4	5
Physics 26	3	2	4
Horticulture:			
Agricultural Economics 26	4	2	5
Horticulture 26	1	4	3
Chemistry 25	2	4	4
or			
Physics 26	3	2	4
Landscape Gardening:			
Drawing 26	–	6	3
Horticulture 26	1	4	3
Mathematics 26	3	–	3
Physics 26	3	2	4
Science:			
Chemistry 25	2	4	4
Modern Language (French or German)	3	–	3
Physics 26	3	2	4
Rural Social Science:			
Agricultural Economics 26	4	2	5
Agricultural Education 29	3	–	3
History and Government 25	3	–	3
Elective (optional)	–	–	3
Rural Home Life:			
Chemistry 30	3	4	5
Drawing 30	–	6	3
Rural Home Life 29	1	6	4

Third Term.

Course and Number.	Class Hours.	Laboratory Hours.	Credit Hours per Week.
Required Groups.			
Group A; for men and women:			
English 27	2	–	2
Group B; for men:			
Military 27 (or Physical Education 32)	–	3	2
Physical Education 26	–	2	1
Group C; for women:			
Physical Education 29	–	5	3
Divisional Elective Groups.			
Agriculture:			
Agricultural Engineering 27	–	4	2
Agricultural Engineering 30	–	8	4
or			
Physics 27	3	2	4
Agronomy 27	3	2	4
English 30	1	–	1
History and Government 27	2	–	2
Microbiology 30	–	6	3
Horticulture:			
Agricultural Engineering 30	–	8	4
Agronomy 27	3	2	4
English 30	1	–	1
History and Government 27	2	–	2
Horticulture 27	5	–	5
Landscape Gardening:			
Drawing 27	–	8	4
English 30	1	–	1
History and Government 27	2	–	2
Horticulture 27	5	–	5
Mathematics 27	–	6	3
Science:[1]			
Botany 26	1	6	4
Chemistry 26	1	4	3
Entomology 28	–	6	3
Modern Language (French or German)	3	–	3
Physics 27	3	2	4
Rural Social Science:			
English 30	1	–	1
History and Government 27	2	–	2
Rural Sociology 27	3	–	3
Elective	–	–	8–11
Rural Home Life:			
Agricultural Engineering 33	2	4	4
English 30	1	–	1
History and Government 27	2	–	2
Microbiology 33	3	2	4
Rural Home Life 32	–	6	3

[1] Fourth Science optional.

MAJORS: JUNIOR AND SENIOR YEARS.

General Statement.

A major consists of 60 credit hours of correlated work, which is arranged l the student and his adviser.

The list of courses found under each major on subsequent pages should not considered as necessarily a rigid program to be followed. The heads of depai ments have suggested this series of courses as the best for the average stude majoring in their departments. Advisers may, however, make modifications suit the particular needs of the student, provided these modifications confoi precisely to the class schedule as published for the year.

Rules governing Majors.

Rule 1. *Election.* — Each student, before the first term of his junior ye shall elect a major subject from the list of majors given below; and this maj shall consist of 60 credit hours of correlated work.

Rule 2. *Minimum Credits.* — The minimum number of credits for graduati shall be 120 junior-senior credit-hours in addition to the satisfactory completion the required courses of the freshman year and of the required and elective grou of the sophomore year.

Rule 3. *Maximum Credits.* — The maximum number of credits for any tei of the junior or senior year shall be 22; the minimum shall be 18.

Rule 4. *Humanities and Rural Social Science.* — A minimum of 18 cre hours in the Divisions of the Humanities and Rural Social Science will be requir of all students during their junior and senior years, with the following restrictic that a minimum of 5 credit hours will be required in each of the divisions.

Rule 5. *Advisers.* — The work of each junior and senior will be under t immediate supervision of an instructor designated as major adviser. Ordinari the major adviser will be the head of the department in which the student ele his major. The adviser has full authority to prescribe the student's work up 60 hours. He will, however, so far as practicable, recognize the individual nee of the student. It is also expected that students will seek the counsel of the advis with respect to the remaining courses required for graduation.

Rule 6. *Free Electives.* — Each student during his junior and senior years required to take 60 hours in his major and also 18 hours in the Divisions of t Humanities and Rural Social Science, making a total of 78 hours (but see Rule He is allowed free choice of courses to complete his required hours.

Rule 7. *Registration.* — No junior or senior shall register until his maj course of study is approved by his adviser.

(1) Course cards for recording the election of majors will be issued from t Schedule Room five weeks before the close of each term.

(2) This card must be submitted by each student to his major adviser, who w lay out the course for the succeeding term and countersign the card.

(3) Each course card must be filled out, giving the name of student, his majo his class and the name and address of parent or guardian. When the major cours have been entered on this card, and the hours of free elections added by the studen the card, accompanied by one hour plan, must be returned to the Schedule Roo two weeks before the beginning of the final examination period.

Rule 8. *Change of Major.* — Applications for change of major may be mac to the dean in writing at any time; when approved by both major advisers co cerned and by the dean and the committee on scholarship, they become operati at the beginning of the term following, provided that no change in the selectic of a major may be made by any student after registration day of his senior yea

MAJOR REQUIREMENTS.

'he following groups of courses represent the requirements of the several majors o he junior and senior years, subject to the regulations stated on page 32. The a bic figure following the name and catalog number of each course represents the c lit-hours.

AGRONOMY. Professor ARTHUR B. BEAUMONT, *Adviser.*

AR.	Term I.		Term II.		Term III.	
J or .	Agronomy 75	5	Agronomy 50	3	Agronomy 51	3
	Animal Husbandry 50	3	Chemistry 25	4	Botany 26	4
	Botany 58	3			Chemistry 26	3
					Geology 52	5
					Physics 27	4
S or .	Agronomy 75	5	Agricultural Engineering 78	5	Agricultural Engineering 79	5
	Botany 78	5	Agronomy 77	5	Agronomy 51	3
	Chemistry 51	6	Botany 79	3	Botany 80	3
	Chemistry 61	5	Chemistry 52	6	Farm Management 77	3
	Farm Management 76	3				

ANIMAL HUSBANDRY. Professor JULIUS H. FRANDSEN, *Adviser.*

AR.	Term I.		Term II.		Term III.	
J ior .	Animal Husbandry 50	3	Agronomy 50	3	Agronomy 51[1]	3
	Dairy 50	5	Animal Husbandry 54	3	Animal Husbandry 52	3
			Farm Management 51	3	Animal Husbandry 53	3
			Veterinary Science 50	5	Dairying 52[1]	5
S or .	Agricultural Engineering 75[1]	5	Agricultural Engineering 78[1]	5	Agronomy 51[1]	3
	Animal Husbandry 75	3	Agronomy 77[1]	5	Animal Husbandry 77	3
	Farm Management 76	3	Animal Husbandry 76	3	Animal Husbandry 80	3
	Veterinary Science 75 or 78	5 or 3	Animal Husbandry 81	1	Animal Husbandry 82	1
			Veterinary Science 76 or 79	5 or 3	Farm Management 81[1]	2
					Poultry 78[1]	5
					Veterinary Science 77 or 80	5 or 3

[1] Suggested but not required.

DAIRY MANUFACTURES. Professor JULIUS H. FRANDSEN, *Adviser.*

AR.	Term I.		Term II.		Term III.	
J ior .	Agricultural Education 51[1]	5	Chemistry 25	4	Agricultural Engineering 81[1]	4
	Animal Husbandry 50	3	Dairying 51	1	Dairying 52	5
	Dairying 50	5	Dairying 77	5	Dairying 53	2
	Dairying 75	3	Economics 51[1]	5	Dairying 78	5
	Dairying 76	4	Microbiology 51	5	Dairying 80	1
	Dairying 79	1	Rural Sociology 51[1]	3	Economics 52[1]	5
			Veterinary Science 50[1]	5		
S or .	Agricultural Economics 83[1]	2	Agricultural Economics 75[1]	5	Agricultural Economics 53	5
	Chemistry 61	5	Agricultural Economics 76	5	Agricultural Economics 84[1]	2
	Dairying 75	3	Animal Husbandry 81	1	Dairying 78	5
	Dairying 76	4	Chemistry 81	5	Dairying 80	1
	Dairying 79	1	Dairying 77	5		
	Microbiology 82	5	Farm Management 51[1]	3		

[1] Suggested but not required.

Farm Management. Professor James A. Foord, *Adviser.*

Year.	Term I.		Term II.		Term III.	
Junior	Animal Husbandry 50 Dairying 50 Pomology 50	3 5 3	Agronomy 50 Farm Management 51 Pomology 51	3 3 3	Agronomy 51[1] Animal Husbandry 52[1] Animal Husbandry 53 Dairying 52[1] Forestry 58	
Senior	Agricultural Engineering 75 Animal Husbandry 75[1] Farm Management 76 Veterinary Science 75	5 3 3 5	Agricultural Engineering 78 Agronomy 77 Animal Husbandry 76[1] Farm Management 78	5 5 3 1	Agricultural Engineering 79 Agronomy 51[1] Animal Husbandry 77 Farm Management 77 Farm Management 79 Farm Management 81[1] Pomology 78[1] Poultry 78[1]	

[1] Suggested but not required.

Poultry Husbandry. Professor John C. Graham, *Adviser.*

Year.	Term I.		Term II.		Term III.	
Junior	Agricultural Education 52[1] Agricultural Engineering 75 Poultry 50	5 5 5	Agricultural Education 55[1] Farm Management 51[1] Poultry 51 Zoölogy 76	5 3 5 3	Agricultural Economics 53 Agricultural Engineering 30[1] Poultry 52 Vegetable Gardening 50[1]	
Senior	Farm Management 76 Poultry 75 Poultry 76 Veterinary Science 78 or 85	3 3 4 3	Agricultural Economics 52[1] Poultry 77 Veterinary Science 79 or 86	5 5 3	Poultry 79 Veterinary Science 80 or 87	

[1] Suggested but not required.

Floriculture. Professor Clark L. Thayer, *Adviser.*

Year.	Term I.		Term II.		Term III.	
Junior	Botany 50 Floriculture 50 Floriculture 53	2 4 4	Botany 51 Floriculture 51	2 4	Floriculture 52 Floriculture 55	
Senior	Floriculture 75 Horticulture 50	3 5	Floriculture 76 Floriculture 79	3 3	Floriculture 77 Floriculture 80 Horticulture 51 Horticulture 75	

Advised. — The department advises all students who major in this subject to take Entomology 50, La scape Gardening 75, Botany 78, 79 and 80, and Agricultural Economics 53, 83 and 84.

Landscape Gardening. Professor Frank A. Waugh, *Adviser.*

Year.	Term I.		Term II.		Term III.	
Junior	Horticulture 50 Landscape Gardening 50 Landscape Gardening 78 or 79	5 5 3	Landscape Gardening 51	4	Floriculture 55 Horticulture 51 Landscape Gardening 52	
Senior	Landscape Gardening 75 Landscape Gardening 76 Landscape Gardening 78 or 79	3 4 3	Landscape Gardening 80 Landscape Gardening 81	4 4	Landscape Gardening 77 Landscape Gardening 82 Horticulture 75	

Pomology. Professor Fred C. Sears, *Adviser.*

EAR.	Term I.		Term II.		Term III.	
ior .	Botany 50 Entomology 50 Pomology 50	2–6 3 3	Pomology 51 Pomology 54	3 3	Agricultural Economics 53 Pomology 52	5 3
ior .	Horticultural Manufactures 75 Pomology 75 Pomology 77 Pomology 89	5 3 3 1	Agronomy 77 Horticultural Manufactures 76 Pomology 76 Pomology 81	5 3 3 1	Agricultural Engineering 78 Horticultural Manufactures 77 Horticulture 75 Pomology 78 Pomology 82	5 2 2 3 1

Vegetable Gardening. Professor Frank A. Waugh, *Adviser.*

EAR.	Term I.		Term II.		Term III.	
ior .	Agronomy 75 Botany 59	5 2	Botany 51 Vegetable Gardening 52	2 5	Agricultural Economics 53 Vegetable Gardening 53	5 5
ior .	Agronomy 75 Floriculture 53 Horticultural Manufactures 75 Vegetable Gardening 75	5 4 5 5	Horticultural Manufactures 76 Vegetable Gardening 76	3 5	Horticulture 75 Vegetable Gardening 77	2 5

Economic Botany. Professor A. Vincent Osmun, *Adviser.*

EAR.	Term I.		Term II.		Term III.	
ior .	Botany 52 Botany 58 or 61 Chemistry 51 English 65[1] French or German 50	3 3 6 3 3	Agronomy 50[1] Botany 53 Botany 59 or 62 Chemistry 52 Entomology 51[1] French or German 51	3 3 3 6 3 3	Agricultural Education 56[1] Botany 54 or Botany 60 or 63 Botany 55 English 52[1] French or German 52 Geology 52[1]	5 3 3 5 3 3 5
ior .	Botany 58 or 61 Botany 75 or Botany 78 Chemistry 80[1]	3 5 5 5	Botany 59 or 62 Botany 76 or Botany 79 Chemistry 86[1] Entomology 90[1]	3 5 3 or 5 3 3	Agricultural Education 56 Botany 60 or 63 Botany 77 or Botany 89	5 3 5 3 or 5

[1] Suggested but not required.

Agricultural Chemistry. Professor Charles A. Peters, *Adviser.*

AR.	Term I.		Term II.		Term III.	
ior .	Chemistry 51 Chemistry 61	6 5	Chemistry 52 Chemistry 62	6 6	Chemistry 53 Chemistry 63	6 5
or .	Chemistry 75 Chemistry 80	6 5	Chemistry 86 Chemistry 90, 92, 94, 96[1]	3 5	Chemistry 87 Chemistry 91, 93, 95, 97[1]	3 5

ote. — A knowledge of German is required. Students having had no German previously should elect it a ne beginning of the sophomore year.

[1] Students will select one course from groups 90, 92, 94, 96 and 91, 93, 95, 97 respectively.

Economic Entomology. Professor Henry T. Fernald, *Adviser*.

Year.	Term I.		Term II.		Term III.	
Junior	Chemistry 51[1] Entomology 52 Entomology 53 French or German 50[1]	6 2 5 3	Botany 51 Chemistry 52[1] Entomology 55 Entomology 56 French or German 51[1]	4 6 4 3 3	Chemistry 53[1] Entomology 57 Entomology 65 Entomology 75 French or German 52[1]	5 2 3 3 3
Senior	Chemistry 80 Entomology 76 Entomology 79 Entomology 85[1] Horticulture 50[1] Zoölogy 50	5 5 3 3 5 3	Entomology 77 Entomology 90 Pomology 79[1] Zoölogy 51	3 3 3 3	Entomology 78 Geology 52 Horticulture 51[1] Pomology 78[1] Zoölogy 52	4 5 5 3 3

[1] Suggested but not required.

Microbiology. Professor Charles E. Marshall, *Adviser*.

Year.	Term I.		Term II.		Term III.	
Junior	Microbiology 50 Microbiology 60	5 3	Microbiology 50 Microbiology 51 Microbiology 61	5 5 3	Microbiology 50 Microbiology 51 Microbiology 52 Microbiology 62	5 5 5 3
Senior	Microbiology 60 Microbiology 81 Microbiology 82	3 5 5	Microbiology 61 Microbiology 75 Microbiology 80	3 5 5	Microbiology 62 Microbiology 76 Microbiology 83	3 5 5

Agricultural Economics. Professor Alexander E. Cance, *Adviser*.

Year.	Term I.		Term II.		Term III.	
Junior	Agricultural Economics 50 Agricultural Education 55 English 65	5 5 3	Agricultural Economics 52 Economics 51 Rural Sociology 51[1]	5 5 3	Agricultural Economics 53 Economics 52 Rural Sociology 52[1]	5 5 3
Senior	Agricultural Economics 77 Agricultural Economics 79	5 5	Agricultural Economics 75 Agricultural Economics 76	5 5	Agricultural Economics 78 Agricultural Economics 87	3 3

[1] Suggested but not required.

Agricultural Education. Professor Winthrop S. Welles, *Adviser*.

Year.	Term I.		Term II.		Term III.	
Junior	Agricultural Education 51 Agricultural Education 55	5 5	Agricultural Education 51 Agricultural Education 55 Agricultural Education 56	5 5 5	Agricultural Education 56	[illegible]
Senior	Agricultural Education 52 Agricultural Education 76 Agricultural Education 80 Agricultural Education 85	5 5 1–5 3	Agricultural Education 75 Agricultural Education 80 Agricultural Education 95	3 1–5 3	Agricultural Education 76 Agricultural Education 77 Agricultural Education 79 Agricultural Education 80 Agricultural Education 81 Agricultural Education 83	[illegible]

Courses in Education advised. — (*a*) For general teaching program six of the following courses: 52, 55, 56, 75, 79, 80, 95. (*b*) For vocational agricultural teaching 51, 56 or 75, 76, 80. (*c*) For extension tea ing 51, 56, 76, 77, 80.

Rural Sociology. Professor Frederick M. Cutler, *Adviser.*

Year.	Term I.		Term II.		Term III.	
Junior .	Economics 50 . . .	5	Economics 51 . . .	5	Economics 52 . . .	5
	Rural Sociology 50 . .	3	Rural Sociology 51 . .	3	Rural Sociology 52 . .	3
Senior .	Agricultural Economics 50 .	5	Agricultural Economics 52 .	5	Agricultural Economics 53	5
	Economics 75 . . .	5	Agricultural Economics 75 .	5	Rural Sociology 81 . .	1–3
	Rural Sociology 79 .	1–3	Rural Sociology 77 . .	3		
			Rural Sociology 80 .	1–3		

Rural Home Life. Professor Edna L. Skinner, *Adviser.*

Year.	Term I.		Term II.		Term III.	
Junior .	Agricultural Engineering 53	4	Rural Home Life 51 . .	5	Agricultural Economics 54	3
	Chemistry 80 . . .	5			Rural Home Life 52 .	5
	Economics 50 . . .	5			Rural Home Life 61 .	3
	Rural Home Life 50 . .	5			Rural Sociology 27	3
Senior .	Horticultural Manufactures 80	4	Horticultural Manufactures 81	3	Rural Home Life 83 .	3
	Rural Home Life 76 . .	4	Rural Home Life 78 . .	3		
	Rural Home Life 81 . .	3	Rural Home Life 82 . .	3		

Description of Courses.

DIVISION OF AGRICULTURE.

Director Haskell (Acting Chairman).

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of courses 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive seniors.]

Agriculture.

1. **I.** 2. **II.** 3. **III.** Agriculture. — Required course for all freshmen. A survey course, tracing the development of man as influenced by agriculture. It considers those problems which our complicated, present-day civilization looks to agriculture to solve, — problems practical, scientific, commercial, sociological. The object of the course is to give to students the agricultural concept, and an appreciation of the close relationship of all lines of human activity to the great problems of agriculture.
3 class hours. Credit, 3.
Assistant Professor Lanphear.

6. **III.** Agricultural Opportunities for Women. — For freshman women. Designed to show the woman who is interested in agriculture what opportunities there are for her in that field, and how she may best take advantage of them. The types of agricultural work for which women are best adapted are discussed. A study is made of some of the special problems which confront the woman farmer, and her best ways of solving them.
2 class hours. Credit, 2.
Miss Hamlin.

Agricultural Engineering.

Professor Gunness, Assistant Professor Markuson, Mr. Pushee, Mr. Newlon.

The courses in agricultural engineering are planned to give a working knowledge of those phases of engineering which apply directly to the farm. It is expected that the student will acquire a clear understanding of modern farm practice as it relates to permanent improvements of the farm and the farmstead, and in the selection and use of farm equipment.

This department has offices in Stockbridge Hall. The work on farm structures is given in the large drawing room in the same building. This room is fitted with thirty drawing tables. Models and blue prints are available for the study of farm buildings. A set of post molds and a machine for making cement tile afford opportunity for practical work with cement.

The agricultural engineering shop is a one-story structure 100 by 126 feet. The carpenter shop in this building is fitted with benches fully equipped with tools for each student. A band saw, woodturning lathe, circular saw and jointer are the power tools. The general repair shop is equipped with forges, benches, drill press, power hammer, shears, and grinders. The laboratory for farm machinery and farm motors is equipped with a complete line of field machines, gasoline engines, tractors and pumps, water systems and farm lighting plants. A complete assortment of engine accessories, consisting of carburetors, magnetos, etc., is available for thorough instruction in gas engines. The instruction on small field machines is given in the basement of Stockbridge Hall, and the work on steam engines and steam heating is given in Flint Laboratory.

Required Courses.

27. **III.** Mechanical Drawing. — For sophomores; juniors and seniors ıay elect. The exercises include lettering, geometric construction, orthographic rojection, isometric drawing, and the making of working drawings of simple farm quipment. This course is for the agricultural student who wishes to learn the se of drawing instruments, the reading of blue prints, and some of the general ractices of drafting valuable to every agriculturist. Students who contemplate aking Agricultural Engineering 75 will find this course helpful.

2 2-hour laboratory periods, credit, 2.
Assistant Professor Markuson.

30. **III.** Shop Practice. — For sophomores; juniors and seniors may elect. 'ractice is given in the use of carpentry tools by exercises in bench work, repair f farm equipment and farm building construction. Exercises in forge work, pipe tting, soldering, babbitting and fitting bearings, lining up shafting, lacing belts nd splicing rope. Practice in the use of machinists' tools, such as file, cold chisel, rill press, lathe, taps and dies.

4 2-hour laboratory periods, credit, 4.
Mr. Pushee and Mr. Newlon.

33. **III.** Mechanics of the Household. — For sophomores. A study of ıechanics in their relation to the household, including heat, light, electricity, the esting, care and maintenance of household equipment and appliances.

class hours. 2 2-hour laboratory periods, credit, 4.
The Department.

Elective Courses.

53. **I.** House Planning and Construction. — For juniors; seniors may ect. Plan designs of the small house will be made. The arrangement of interior quipment, especially in the kitchen; lighting; heating; water supply; and sewge disposal will be studied together with a brief history of the house, materials, onstruction methods, equipment, and architectural styles. Consideration will e given to the economics of house building, including financing, maintenance and verhead expense.

class hours. 2 2-hour laboratory periods, credit, 4.
Assistant Professor Markuson.

75. **I.** Farm Structures. — For seniors; juniors may elect. A study of the rength and durability of concrete, wood, stone, and clay products, and of the echanical principles underlying their use in farm construction. The design of arious farm buildings, such as the general purpose barn, dairy stable, hog house, ıeep barn, milk house, etc. In the drafting room, details of construction will be orked out, a study of the mechanics of simple roof trusses will be made, and a omplete design of some major farm building will be finished in all essential details. lueprints of the finished design will be made.

class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor Markuson.

78. **II** and **III.** Farm Motors. — For seniors; juniors may elect. This ourse deals with the gasoline engine as used for stationary work, automobiles ıd tractors. The theory of the internal combustion engine is taken up in order emphasize the effect of design and operation on power and economy. The arious types of carburetors, ignition, and lubrication systems are studied in detail. ıstruction is given by means of lectures and textbooks, and by operating and epairing stationary engines, automobiles and tractors. Special attention is given overhauling and repairing.

class hours. 2 2-hour laboratory periods, credit, 5.
Professor Gunness and Mr. Pushee.

79. **III.** Drainage and Irrigation Engineering. — For seniors; junior may elect. Covers the engineering phase of drainage and irrigation. The variou systems are studied, and practice is given in the design of drainage and irrigatio systems. Field work gives practice in surveying for drains, platting, locatin drains, erecting batterboards and laying tile. Practice is given in assemblin equipment for spray irrigation, and the flow of water through nozzles is studie by means of laboratory tests.
2 class hours. 2 3-hour laboratory periods, credit, 5
Assistant Professor Markuson.

81. **III.** Dairy Mechanics. — For juniors; seniors may elect. A study o dairy machinery, including steam boilers, engines, pumps, traps, refrigeratio machinery, and heat-controlling devices. Practice is given in pipe fitting, packin valves, lacing belts, and similar repair jobs on the equipment used in dairy plant
3 class hours. 1 3-hour laboratory period, credit, 4
Professor Gunness and Mr. Newlon.

Agronomy.

Professor Beaumont, Assistant Professor Cubbon, Mr. Thayer.

The courses in agronomy are designed to give fundamental instruction concern ing the soil and the principal products of the field. The basic course in soils i required of students majoring in the divisions of agriculture, horticulture, an rural social science. The introductory course in field crops is required of student electing major work in agriculture. The elective courses are designed to mee the needs of those specializing in soils and field crops and other specialized field in pure and applied science.

The department is located in Stockbridge Hall. Laboratories for soils an fertilizers include one for elementary work, supplied with locker equipment fo 200 students, and one for advanced work, accommodating 80 students. Thes laboratories are equipped with apparatus necessary for the study of soils an fertilizers, including ovens, balances, centrifuge, microscopes, etc. Storerooms stockrooms and balance rooms are conveniently near the laboratories. There i also a workroom attached, equipped with power machinery for grinding soil fodders, and similar materials.

The laboratories for crops include one for seed study with lockers for 50 student and one for the study of cereals, forage crops, roots, etc., with lockers for 48 stu dents. The equipment of these laboratories includes steam ovens, constant tem perature electric ovens, ovens for seed germination, Brown-Duval moisture ap paratus, balances, microscopes, and collections of seeds, grasses, tubers, weeds etc. Root cellars and a special grain storeroom are also used for crops work.

A modern steam-heated greenhouse and a contiguous head-house used for worl in soils and crops, are a valuable part of the equipment. Near the greenhouse i a crop garden, in which different varieties of corn, grasses, clovers, etc., are grow as demonstrations and as a source of material for class work. In addition, th general college farm of 250 acres is used for field study in soils and crops and as a source of material.

Required Courses.

25. **I.** Field Crop Production. — For sophomores. Field crops contribut the greatest proportion of the agricultural wealth of our country. This is a introductory course designed to acquaint the student with the most importan field crops, methods of production and the problems arising in their culture.
2 class hours. 2 2-hour laboratory periods, credit, 4
The Department.

27. **III.** Soil Management. — For sophomores. The soil is the indispen sable basis for economic crop production. This is an introductory course in whicl the whole subject is covered in a general way, and includes a study of soils an their properties, classification, management, methods of improvement and mainte

ınce of fertility. The use of manures, fertilizers and soil amendments will be ven as much attention as the time allows. Students taking this course should ıve had elementary training in the natural sciences.
class hours. 1 2-hour laboratory period, credit, 4.
The Department.

Elective Courses.

50. **II.** Crop Production for Dairy and Stock Farms. — For juniors; niors may elect. An intensive study of forage crops, tubers and roots and the oblems of their production under New England conditions. Special attention ill be given to the conditions found on the Massachusetts general farm on which ıirying and stock raising are important.
class hours. 1 2-hour laboratory period, credit, 3.

51. **III.** Advanced Field Crops (1926–27). — For juniors and seniors. ıis course is designed primarily for those specializing in field crops. Studies gun in course 50 will be continued and extended to crops of importance beyond e range of New England. Theory and practice of crop improvement by plant eeding will be given attention. Given in alternate years.
class hours. 1 2-hour laboratory period, credit, 3.

erequisite, Agronomy 50.

75. **I.** Advanced Soils (1927–28). — For juniors and seniors. A continua- ɔn of studies begun in Agronomy 27 with special emphasis placed on soil classifi- tion and land utilization. Problems arising in the management of extreme soil pes and specific problems of moisture control and tillage will be given special nsideration. Given in alternate years.
class hours. 1 4-hour and 1 2-hour laboratory period, credit, 5.
Professor Beaumont.

erequisite, Agronomy 27.

77. **II.** Manures, Fertilizers and Soil Amendments. — For juniors and ıiors. An advanced course in which are studied manures, fertilizers and other ıterials applied to the soil for crop nutrition; experimental work bearing on il fertility and plant nutrition; and theory and practice concerning the use of ınures, fertilizers, and lime.
class hours. 2 2-hour laboratory periods, credit, 5.
Professor Beaumont and Assistant.
erequisite, Agronomy 27; advised, Chemistry 61.

Animal and Dairy Husbandry.

fessor Frandsen, Assistant Professor Rice, Assistant Professor Glatfelter, Assistant Professor Smith, Mr. Mack.

This department is equipped to give complete courses of training in dairy and imal husbandry lines. In addition to Flint Laboratory, the dairy manufactures ilding, with its modern equipment for the manufacture of dairy products, there ıalso available a dairy herd comprising some one hundred and sixty head of good ɔresentatives of the Ayrshire, Guernsey, Holstein-Friesian and Jersey breeds. Grinnell Arena, the judging pavilion, offers excellent facilities for the scoring d judging of all farm animals, for in addition to the dairy breeds mentioned ove there are available representatives of the following breeds: Percheron draft rses, Shorthorn cattle, Hereford beef cattle, Southdown and Shropshire sheep, d Chester White and Berkshire swine. All of these facilities offer exceptional portunities to students interested in the various phases of live-stock enterprises. The well-arranged and equipped college farm and barns give students splendid portunities to study the best methods of managing a farm devoted primarily to production of feed crops together with their efficient disposal to live stock.

Courses are offered to meet the needs of students interested in:

Animal Husbandry Group.

The various phases of live-stock farming and market milk production.
Agricultural college teaching.
High and secondary school teaching.
Federal, state, railroad, bank or breed extension services.
Federal or state experiment station service.
Meat packing industry.
Commercial feed industry.

Dairy Manufactures Group.

The handling of market milk and th science and art of butter making, ic cream making, and cheese making
Agricultural college teaching and ex periment station work.
High school or secondary school teach ing.
Extension work.
Research and investigational work.
Graduate work to broaden a knowledg of dairying.

Animal Husbandry.

Required Courses.

25. I. Dairy Breeds. — For sophomores; juniors and seniors may elec This course includes a survey of the dairy industry. The origin, history, develo ment and characteristics of the dairy breeds, and their adaptability to New En land conditions are studied. Preliminary work in scoring animals according the recognized standards is given, followed by comparative judging and placing.
2 class hours. 1 2-hour laboratory period, credit,
Professor Frandsen and Assistant Professor Rice.

26. II. Horses, Swine, Sheep and Beef Cattle. — In this course consi eration is given to the origin, history, development and characteristics of t breeds of horses, swine, sheep and beef cattle. Types, market classes and grad of live stock are studied, together with their economic importance to the count in general, and Massachusetts in particular. Preliminary work is given in scori each type of animal, followed by judging and placing of groups. Textbook Types and Market Classes of Livestock, Vaughan; Types and Breeds of Far Animals, Plumb.
2 class hours. 1 2-hour laboratory period, credit,
Assistant Professor Glatfelter.

Elective Courses.

50. I. The Nutrition of Farm Animals. — For juniors; seniors may elec This course consists of a study and application of the principles of physiologi chemistry to the practical problems of animal feeding and growth. Considerati will be given to the chemical composition of plant and animal life; physiology digestion; functions of vitamines, minerals, protein and energy; feeding standar and their application; the composition of farm crops, their by-products, and co mercially mixed feeds; and their utilization for the economical production live stock and their products.
3 class hours. Credit,
Assistant Professor Rice.
Prerequisites, Animal Husbandry 25 and 26.

52. III. Advanced Live stock Judging. — For juniors; seniors may ele This course serves as a laboratory supplement to Animal Husbandry 53. It h three aims: (a) to train the student to see and evaluate differences in farm anima (b) to begin the training of men who will act as judges of live stock at fairs; (c) develop judging teams in both Fat Stock and Dairy Cattle to represent the Colle in the intercollegiate live stock judging contest at the leading expositions. Tri will be taken each Saturday during the term to the leading herds and flocks Massachusetts and nearby states.
1 2-hour laboratory period on Friday and all day Saturday, credit,
Assistant Professor Rice.
Prerequisites, Animal Husbandry 25 and 26.

53. **III.** The Breeding and Improvement of Farm Animals. — For juniors; seniors may elect. This course is planned to give a broad view of the rise of many types and breeds from one ancestral stock; to note the origin, value and permanence of certain variations and to make clear the reasons for certain excellencies. The course also deals with the physiology of reproduction and genetics as a foundation for experience in actual production.
3 class hours. Credit, 3.
Assistant Professor Rice.
Prerequisites, Animal Husbandry 25 and 26; Zoölogy 26.

54. **II.** Meat and Meat Products. — For juniors; seniors may elect. This course deals with the manufacture of animals into their various commercial products and the distribution of these products to the consumer. Practice is given in the slaughtering of beef cattle, hogs and sheep; judging of carcasses; cutting and curing of meats. The practical work is augmented by studies in the grading of fat stock; packing house methods; the magnitude and trends of the meat industry, and the opportunities of local New England marketing.
1 class hour. 1 4-hour laboratory period, credit, 3.
Assistant Professors Rice and Glatfelter.

75. **I.** Dairy Cattle and Milk Production. — For seniors. A consideration is given to the application of the principles of animal nutrition to the particular problems of dairy cattle feeding. Methods of feeding for high milk production are studied. Cost of milk production, and breeding and management problems are carefully considered. A survey is made of recent experiment station results.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Rice.
Prerequisites, Animal Husbandry 25, 50, 52, 53.

76. **II.** Beef and Sheep Production. — For seniors. Application is made of the principles of nutrition to the feeding of beef cattle and sheep. Feeding, breeding, and management problems are considered. A survey is made of recent experiment station work, and special study is given to the opportunities for the Massachusetts farmer in producing high quality beef and lamb.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Glatfelter.
Prerequisites, Animal Husbandry 26, 50, 52, 53.

77. **III.** Horses and Swine Production. — For seniors. This course is planned to familiarize students with the application of the principles of nutrition to the feeding of horses and swine. Physiological and economic factors are considered in selecting suitable feeds. Cost of production, breeding and managerial problems in commercial horse and pork production are considered. A study is also made of recent experiment station results in feeding, breeding and management.
2 class hours. 1 2-hour laboratory period, credit, 3.
Assistant Professor Rice.
Prerequisites, Animal Husbandry 26, 50, 52, 53.

80. **III.** Dairy Herd Management. — For seniors. The course consists of a study of systems of management of dairy herds; record form; methods of cost accounting; fitting for production, show and sale; cow testing and bull association work.
2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Frandsen and Assistant Professor Rice.

81. **II.** Animal Husbandry Seminar. — Required of students majoring in Animal Husbandry. Students will prepare original papers and talks on various pertinent topics. Round table discussions of animal husbandry investigational

work and practices will be conducted. Frequent addresses will be made to the class by prominent breeders, and scientists.
1 class hour. Credit, 1.
The DEPARTMENT.

82. **III.** ANIMAL HUSBANDRY SEMINAR. — A continuation of 81 **II.**
1 class hour. Credit, 1.
The DEPARTMENT.

DAIRYING.

Elective Courses.

50. **I.** GENERAL DAIRYING. — For juniors; seniors may elect. A general course, prerequisite to all other dairy courses, except courses 51 and 53, and for those who wish to take only one course in dairying to get a general knowledge of the subject. The work covers briefly a study of milk, its secretion, composition and various tests applied thereto; methods of handling milk and cream; the use of separators; elements of butter making, cheese making and ice cream making.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Professor FRANDSEN and Assistant Professor SMITH.

51. **II.** JUDGING DAIRY PRODUCTS. — For juniors; seniors may elect. A study of standards and grades of dairy products, with practice in judging milk and ice cream as well as butter and cheese. The student learns to recognize quality in dairy products and to detect specific defects; their causes and prevention.
1 2-hour laboratory period, credit, 1.
Mr. MACK.

52. **III.** MARKET MILK. — For juniors; seniors may elect. A study of the various phases of the market milk industry, sanitary production; transportation marketing; handling in the city plant; delivery systems; milk and its relation to the public health; inspection; milk laws; food value and advertising. Some milk plants will be visited.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor SMITH and Mr. MACK.
Prerequisite, Dairy 50.

53. **III.** ADVANCED JUDGING OF DAIRY PRODUCTS. — For juniors; seniors may elect. The judging of milk, ice cream, butter and cheese using standard commercial methods and official score cards. A team is chosen from this class to represent the college in dairy products judging contests at the Eastern States Exposition and the National Dairy Show.
2 2-hour laboratory periods, credit, 2.
The DEPARTMENT.
Prerequisite, Dairy 51.

75. **I.** MILK PRODUCTS (1927–28). — For juniors and seniors. The manufacture of milk products other than butter and ice cream, including cheddar cheese soft and fancy cheese, condensed and powdered milk, casein, commercial buttermilk, etc. Laboratory exercise largely in cheese making and commercial buttermilk manufacture. Given in alternate years.
1 class hour. 1 4-hour laboratory period, credit, 3.
Mr. MACK.
Prerequisite, Dairy 50, previously or in conjunction.

76. **I.** ADVANCED TESTING (1926–27). — For juniors and seniors. Work covers moisture and fat testing for all dairy products; the casein test; salt test for butter; acid tests; work with the Mojonnier apparatus and many other applied chemical tests used in dairy manufacture work. Given in alternate years.
2 4-hour laboratory periods, credit, 4.
Mr. MACK.
Prerequisite, Dairy 50, previously or in conjunction.

77. **II.** Butter Making (1927–28). — For juniors and seniors. A study of parators and cream separation; handling milk and cream for butter making; eparation of starters, and ripening cream; churning; markets and their requireənts; marketing, scoring and judging butter; management; butter making ıchinery and care thereof; problems. Given in alternate years.
ɜlass hours. 2 3-hour laboratory periods, credit, 5.
Assistant Professor Smith.

ıerequisite, Dairying 50.

78. **III.** Ice Cream Making (1926–27). — For juniors and seniors. A study the principles and practice of ice cream making. Laboratory equipment is ɔdern and the laboratory instruction will cover commercial practices. Some cream plants will be visited. Given in alternate years.
ɜlass hours. 2 3-hour laboratory periods, credit, 5.
Assistant Professor Smith.

erequisite, Dairying 50.

79. **I.** Seminar. — For students majoring in dairy manufactures. This urse consists of a study of the work accomplished by various experiment stations, ɔo a review of foreign literature. Students will prepare papers on various dairy bjects. Frequent addresses will be made to the class by visiting dairy authorities.
ɜlass hour. Credit, 1.
Professor Frandsen.

80. **III.** Seminar. — Continuation of Course 79.
ɜlass hour. Credit, 1.
Professor Frandsen.

Farm Management.

Professor Foord, Assistant Professor Barrett.

The purpose of the courses in this department is to present various considerans of farming as a business. This involves a knowledge of the cost of production d the profit from the different enterprises such as dairy, poultry or orchard; a ıdy of the enterprises, and the relative amounts of each that will give the best e of labor and equipment on the farm under consideration.

The college farm of 250 acres is under the general supervision of the Department Farm Management, and furnishes demonstration material. It includes improved ıd, pasture land and a farm woodlot. The improved land illustrates the value good culture and the best known methods for the maintenance of fertility. ıe farm is equipped with suitable buildings and good machinery for the work rried on, of which the production of certified milk is an important branch. Sevıl good farms in the vicinity, illustrating types of both special and general agrilture, may be inspected and studied. The offices of the department are in ɔckbridge Hall.

Elective Courses.

51. **II.** Farm Accounts and Cost Accounting. — For juniors; seniors may ɛct. A study of farm inventories, single-enterprise accounts, complete farm counts and farm records. Special emphasis is given to the interpretation of ɜults and their application in the organization and management of the farm.
3 2-hour laboratory periods, credit, 3.
Professor Foord.

76. **I.** Farm Management. — For seniors; juniors may elect. A study of ːming as a business; regions and types of farming; the general principles of ːm management and the influence of size, production, live stock and crop farmɡ on the farmer's labor income; arrangement of fields and buildings; use of ıd, capital and labor; choosing and buying a farm.
ɜlass hours. 1 2-hour laboratory period, credit, 3.
Professor Foord.

erequisites, Agronomy 50, Animal Husbandry 25 and 26, and some farm experience.

77. **III.** Farm Management. — For seniors; juniors may elect. A furth and more specific study of the principles and practices as outlined in Course 7 with reference to their application to different regions of the United States ar especially to New England. Trips to successful farms are a required part of t course.

1 class hour. 1 4-hour laboratory period, credit,

Professors Foord and Barrett.

Prerequisites, Farm Management 51 and 76.

78. **II.** Seminar. — For seniors majoring in general agriculture; others b arrangement.

1 class hour. Credit,

Professors Foord and Barrett.

79. **III.** Seminar. — For seniors majoring in general agriculture; others b arrangement.

1 class hour. Credit,

Professors Foord and Barrett.

Poultry Husbandry.

Professor Graham, Professor Sanctuary, Assistant Professor Banta, Miss Pulley.

The introductory courses (50, 51, 52) give a knowledge of the general routi of elementary poultry keeping. The advanced or senior courses prepare men f the successful operation of poultry plants, either as owners or managers, for grad ate work, for teaching, extension or investigational work.

The poultry plant consists of 8 acres of land. The buildings consist of inc bator cellars equipped with a number of lamp incubators and four mammo machines with a total capacity of 11,000 eggs, a new 72 foot brooder house ar about 40 colony brooder houses and growing coops having a capacity for 7,0 chicks. The brooder houses are equipped with a great variety of brooder stov and other necessary equipment for brooding and growing chicks.

A large number of laying and breeding houses furnish quarters for nearly 2,0 laying birds and ample facilities for student practice work in pen managemer culling, judging, and pedigree work. Laboratories at the plant and Stockbrid Hall are used for practicums in killing, picking, drawing, trussing, packing, gradin fattening, and poultry carpentry and other necessary practices that have to do wi poultry keeping.

In addition to furnishing laboratory facilities, the college plant and the E periment Station farm present live problems bearing either directly or indirect upon commercial poultry keeping and data from these are available for studer use. Our experimental breeding plant being an integral part of our departmer organization is an asset of untold value.

Elective Courses.

50. **I.** Poultry Judging. — For juniors; seniors may elect. A study the origin and evolution of our standard breeds and varieties of domestic fow judging production quality, using trapnested birds, judging exhibition quality b score card and comparison. One or more poultry farms, an egg-laying conte and a poultry show will be visited. Poultry judging teams competing in the Inte collegiate contest at Madison Square Garden each January are trained in th course.

2 class hours. 2 3-hour laboratory periods, credit,

Assistant Professor Banta.

51. **II.** Poultry Feeds and Feeding. — For juniors; seniors may elect. study of the common feeds and the scientific principles underlying the field o nutrition. Recent experimental work and current feeding problems will receiv special consideration. For observational practice and accumulation of origin data, the management of a pen of birds will be required for a period of a few week

3 class hours. 2 2-hour laboratory periods, credit,

Assistant Professor Banta.

52. **III.** Incubation and Brooding. — For juniors; seniors may elect. A ,udy of the fundamental principles underlying incubation and brooding practices. he science of physics and general biology are applied to the study of incubation nd brooding processes. Students become thoroughly acquainted with modern ıcubation and brooding equipment through detailed study and operation of /pical incubators and brooders. Present day problems are considered and some re investigated as a part of the class work.
class hours. 3 2-hour laboratory periods, credit, 5.
Professor Sanctuary and Miss Pulley.

75. **I.** Poultry Housing and Sanitation. — For seniors. A consideration f the biological needs of poultry from the standpoint of housing, the economic rinciples governing designing and construction of poultry houses and equipment for oultry farm buildings. The course also embodies a study of the principles of poultry ınitation including external parasites and the insecticidal agents for their control.
class hours. Credit, 3.
Assistant Professor Banta.

76. **I.** Market Poultry and Poultry Products. — For seniors. A study f market classes of poultry and eggs; preparation of poultry products for market; equirements of different markets; methods of marketing involving a study of istribution, finances and business organizations; cold storage and transportation; dvertising, prices and food values. Laboratory exercises in candling, packing, illing, dressing and similar operations to make the above named factors more oncrete. Students are required to fatten pens of chickens by different methods nd rations, keeping accurate data of the gains in weight and quality, also the osts of feed and labor, and resultant profit or loss. Competitive judging of the xhibits in the Annual Market Poultry Show, staged by the members of this class, a feature of the course. When possible, a short trip to Springfield is arranged to udy cold storage plants and the handling of poultry products in the local market.
class hours. 2 2-hour laboratory periods, credit, 4.
Miss Pulley.

77. **II.** Poultry Breeding. — For seniors. Methods of selection and improvement of poultry are developed through study of the principles of heredity. Iost of the course centers around the progeny test and pedigree method of breeding. Students taking this course participate in the college plant selection in edigree work. Three breeds of poultry each pedigreed for from seven to twenty ears furnish practice materials.
class hours. 1 2-hour laboratory period, credit, 5.
Professor Sanctuary.

78. **III.** Farm Poultry. — For seniors; juniors may elect. For those students who desire a general knowledge of poultry husbandry but who cannot evote more than one term to the subject; it is not intended for students specializing in poultry, and such students are admitted only by special permission. Emhasis is placed on the farm flock and its economic management. Utility classication, housing, culling, feeding, hatching, rearing, production, marketing and isease control receive special consideration.
class hours. 2 2-hour laboratory periods, credit, 5.
Assistant Professor Banta.

79. **III.** Poultry Farm Organization. — For seniors. This course embodies he application of economic and business principles to poultry farming. The lace and importance of the various branches of well organized poultry farms and heir relation to each other receive special consideration; also the study of surveys and production costs. A trip covering two or three days will be made to epresentative successful poultry farms. The expense per student is approximately 15. This is required of each student taking the course for credit.
class hours. 1 2-hour laboratory period, credit, 4.
Professor Graham.

Prerequisite, Poultry 77.

DIVISION OF HORTICULTURE.

Professor WAUGH.

[Heavy-faced Roman numerals indicate the term in which the course is given. Numbering of cour: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusi seniors.]

Floriculture.

Professor THAYER, Assistant Professor MULLER.

The courses in floriculture are intended to present a general knowledge of phases of greenhouse design, construction, heating and management, the cultu of florists' crops (under glass and in the field), floral decoration and arrangeme The department aims to train students so that they may take up commerc floriculture (either in the growing or retail business) and the management of co servatories on private estates, in parks and cemeteries.

The department is especially well equipped for the teaching work. Fren Hall, with its laboratories, classrooms and offices, furnishes excellent facilities the purposes of instruction. The glass area of the department consists of a proximately 20,000 square feet, divided as follows: French Hall range of 7,2 square feet, a durable, practical, commercial range composed of palm and fe sweet pea, carnation, rose and students' houses; the old Durfee range of 7,4 square feet, devoted to the growing of decorative, conservatory and beddi plants and chrysanthemums; one house of 3,200 square feet, suitable for pro gating work and general plant culture; and approximately 2,200 square feet cold frames and hotbeds.

In addition, the department has 2 acres of land used for the summer culture carnations, galdioli, dahlias, sweet peas, bedding plants, etc. This also incluc a small garden devoted to the culture of annuals. A large collection of bienni and herbaceous perennials is maintained and is being enlarged from year to year; present the collection consists of several hundred species and varieties, and provic an excellent opportunity for the study of garden flowers. A small rose gard is to be planted in the near future.

Elective Courses.

50. **I.** GREENHOUSE MANAGEMENT. — For juniors; seniors may elect. D signed to familiarize students with the methods followed in the management greenhouses and of greenhouse crops and the principles underlying the san history and development of the floricultural industry; preparation of soils; fe tilizers; potting; watering; ventilation; control of insects and diseases; metho of plant propagation; forcing of plants. At some time during the term the mer bers of the class will be required to take a one-day trip to visit large commerc establishments. Lectures, assigned readings, reports and laboratory practice.
2 class hours. 2 2-hour laboratory periods, credit,
Assistant Professor MULLER.

Prerequisite, Horticulture 25, 26 and 27.

51. **II.** GREENHOUSE MANAGEMENT. — For juniors; seniors may elect. Co tinuation of Course 50. Several field trips, to study floricultural establishmen in the vicinity, will be made during the laboratory periods.
2 class hours. 1 4-hour laboratory period, credit,
Assistant Professor MULLER.

52. **III.** FLORAL ARRANGEMENT. — For juniors; seniors may elect. A stuc of the principles underlying the arrangement and use of cut flowers and plant funeral designs, basket and vase arrangement, table decorations, home, churc and all interior decorations; a study of color as applied to such work. Lecture assigned readings and reports. This course will be limited to ten students.
2 class hours. 2 2-hour laboratory periods, credit,
Professor THAYER.

53. **I.** Greenhouse Construction and Heating. — For juniors; seniors may elect. The location, types, arrangement, construction, cost, equipment, heating and ventilating of greenhouse structures; the drawing of plans and study of specifications for commercial houses and conservatory ranges. Such practical work as glazing and the construction of concrete benches and cold frames is included as facilities allow. Lectures, assigned readings and problems.

3 class hours. 1 2-hour laboratory period, credit, 4.

Professor Thayer.

55. **III.** Garden Flowers and Bedding Plants. — For juniors and seniors. A study of the annuals, biennials, herbaceous perennials, bulbs, bedding plants and roses that are valuable for use in floricultural or landscape gardening work. Methods of propagation, culture and uses of the various plants are considered; identification of material. Lectures, assigned readings and reports.

2 class hours. 1 2-hour laboratory period, credit, 3.

Professors Thayer and Muller.

75. **I.** Commercial Floriculture. — For seniors. A detailed study of the important commercial cut flower crops and potted plants. Visits will be made to commercial establishments during the term. The lectures are supplemented with textbooks and assigned readings.

2 class hours. 1 2-hour laboratory period, credit, 3.

Professor Thayer.

Prerequisite, Floriculture 51.

76. **II.** Commercial Floriculture. — For seniors. As stated under Course 75.

2 class hours. 1 2-hour laboratory period, credit, 3.

Professor Thayer.

Prerequisite, Floriculture 75.

77. **III.** Commercial Floriculture. — For seniors. As stated under Course 75.

2 class hours. 1 2-hour laboratory period, credit, 3.

Assistant Professor Muller.

Prerequisite, Floriculture 76.

79. **II.** Conservatory Plants. — For seniors. A study of the foliage and flowering plants used in conservatory work; methods of propagation, culture, use and arrangement; identification of plants. Lectures, assigned readings and reports.

2 class hours. 1 2-hour laboratory period, credit, 3.

Professor Thayer.

80. **III.** Seminar. — For seniors majoring in floriculture. Advanced study of subjects pertaining to some phase of floriculture. All students are assigned specific problems and pursue study in these problems by reading and research; the results of this study must be presented in the form of a thesis. Seminars are conducted weekly.

1 class hour. 2 to 4 laboratory hours, not to exceed 3 credits.

Professor Thayer.

Forestry.

Professor Grose.

The forestry courses are intended primarily for prospective owners or managers of farm woodlots, and the field work is focused on typical New England problems. These courses are broad enough, however, to furnish valuable preparation for students planning to study forestry in graduate schools.

The department has an unusually complete equipment of the various instruments used in forest mensuration, forest mapping and engineering, timber estimating, log scaling, board measuring, etc.; and a large assortment of boards illustrative of the various commercial woods found in the lumber markets. The State Forest Nursery, comprising 14 acres of land and containing, approximately 10,000,000 trees, transplants and seedlings, is on the college farm. Forests containing every variety of tree common to New England are within walking distance of the college. The college campus affords an arboretum containing a large number of trees not native to New England. The Mount Toby Demonstration Forest has an area of approximately 750 acres, and contains the various types of forest growth found throughout the State. It serves as a field laboratory in which students have the privilege of working out problems in silviculture, forest mensuration and management. Improvement cuttings, cuttings for utilization, and forest plantings are conducted by the department.

55. **I.** Woodlot Forestry: Estimating and Business Management. — For juniors and seniors. Topics: forest mapping; timber-cruising; determining rate of growth and possible cut; financial returns; forest taxation; our national timber supply, present and future.

1 2-hour and 1 4-hour laboratory period, credit, 3.
Professor Grose.

56. **II.** Woodlot Forestry: Logging, Milling and Marketing. — For juniors and seniors. Topics: felling trees; sawing logs; hauling logs; the portable mill; the stationary mill; seasoning, measuring and shipping lumber; lumber grades and prices; legal forms; by-products of the woodlot; adaptability of species to uses; wood-using industries of Massachusetts.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Grose.

Prerequisite, Forestry 55.

57. **III.** Woodlot Forestry: Timber-raising. — For juniors and seniors. Topics: forest planting; weeding; release cuttings; pruning; thinning; salvage cutting; protection from insects, fungi, fire, etc.; final cutting methods for natural reproduction of the forest.

1 2-hour and 1 4-hour laboratory period, credit, 3.
Professor Grose.

58. **III.** Woodlot Forestry: Brief Survey. — For juniors and seniors. A condensation of Courses 55, 56 and 57 for those who have only one term to give to forestry.

2 class hours. 1 2-hour laboratory period, credit, 3.
Professor Grose.

Horticultural Manufactures.

Professor Chenoweth, Mr. Robertson.

The courses aim to give a practical knowledge of the problems connected with food preservation. Emphasis is placed upon the conservation of the cheaper grades of fruits and vegetables, to the end that the whole crop may be marketed at a profit and that wholesome food products may result from what would otherwise be lost. The social and economic values of this work are constantly emphasized.

The department occupies three laboratory rooms in Flint Laboratory, two in Fisher Laboratory, with offices in Wilder Hall and French Hall. The general equipment of the department, both for the use of students and for manufacturing purposes, may be grouped under the following heads: —

1. *Canning.* — A modern canning outfit, including both steam-pressure cookers and hot-water baths, hand and power can sealers, peeling and slicing machines, a string bean cutter, heat-penetration thermometers, electric incubator and a large assortment of all types of home canning equipment.

2. *Evaporation.* — Two small orchard evaporators, a tunnel drier, peeling achines, slicers and a general assortment of driers adapted to home evaporation.
3. *Fruit Juices, Butters, etc.* — A hand cider mill, a motor-driven hydraulic ress, a steam-jacketed kettle, an apple-butter cooker, and cider and vinegar sting apparatus.

Elective Courses.

75. **I.** HORTICULTURAL MANUFACTURES. — For seniors and graduate stu- ents. A practical course in food preservation dealing primarily with fruits d vegetables. The canning of fruits and vegetables as practiced in the home d in commercial canneries; evaporation of fruits and vegetables, the various pes of equipment and methods of preparation of products. The manufacture (*a*) fruit products, such as butters, jams, jellies, fruit juices, marmalades, reserves, vinegars, pastes, etc.; (*b*) vegetable products, as pickles, piccalilli, uerkraut, soups, etc. Particular attention is given to study and use of all types equipment suitable for use in the home or small factory, together with methods r testing a large variety of manufactured products. The emphasis is on canning, rying and study of equipment.
class hours. 3 2-hour laboratory periods, credit, 5.
Professor CHENOWETH.

76. **II.** HORTICULTURAL MANUFACTURES. — For seniors and graduate stu- ents. A continuation of Course 75. The emphasis in this course is placed on e manufacturing and testing of fruit and vegetable products.
class hour. 2 2-hour laboratory periods, credit, 3.
Professor CHENOWETH.
rerequisite, Horticultural Manufactures 75.

77. **III.** HORTICULTURAL MANUFACTURES. — For seniors and graduate stu- ents. Continuation of courses 75 and 76, dealing primarily with maple products, e canning of meats and spring vegetables, and studies of special problems in- lved in establishing and operating home and farm factories.
2 2-hour laboratory periods, credit, 2.
Professor CHENOWETH.

78. **III.** HORTICULTURAL MANUFACTURES. — For seniors and graduate stu- ents. A general course in food preservation, including lectures, readings and boratory work in the canning and evaporation of fruits and vegetables, the anufacture of fruit and vegetable products. Special emphasis will be given to e conservation of the low-grade fruits and vegetables in the home and in the rm factory.
class hours. 2 2-hour laboratory periods, credit, 4.
PROFESSOR CHENOWETH.

80. **I.** HORTICULTURAL MANUFACTURES. — For senior women. A course ealing with the problems of food preservation in the home. Application of esent-day knowledge to the practices of canning, pickling, drying and the manu- cture of fruit and vegetable products in the home.
class hours. 2 2-hour laboratory periods, credit, 4.
Professor CHENOWETH and Mr. ROBERTSON.

81. **II.** HORTICULTURAL MANUFACTURES. — For senior women. A continua- on of Course 80. The emphasis will be placed on methods of preserving the small uits, home storage of fruits and vegetables, the preservation of foods with salt d the manufacture of a variety of vegetable pickles, the manufacture of fruit rups and their blending to form fruit beverages, the manufacture of fruit candies d candied fruits.
class hour. 2 2-hour laboratory periods, credit, 3.
Professor CHENOWETH.

Horticulture.

Professor Waugh, Professor Thompson, Assistant Professor Drain, Mr. French.

The general subject of horticulture divides naturally into subjects of pomolog floriculture, forestry, landscape gardening and vegetable gardening. A number courses relate to more than one of these subjects, and are therefore grouped he under the general designation of horticulture.

Required Courses.

25. **I.** Relationships and Associations of Horticultural Plants. — For sophomores. A study of the outstanding characters utilized in acquiring practical knowledge of the principal species and varieties of cultivated plant together with a consideration of those principles which determine the natur associations of plants in so far as they bear on the best methods of plant cultur
1 class hour. 2 2-hour laboratory periods, credit,
Professor Thompson.

26. **II.** Horticultural Practices. — For sophomores. This course designed to demonstrate and explain the principles underlying the practical cult vation of economic plants. Consideration will be given to the methods of prop gation and to the culture of plants in their relation to soils, tillage, water an food supply, etc.
1 class hour. 2 2-hour laboratory periods, credit,
Assistant Professor Drain.

27. **III.** Breeding of Horticultural Plants. — For sophomores. A stud of the principles of inheritance as applied to plants; together with a consideratio of the methods used and problems involved in the improvement of horticultur crops.
5 class hours. Credit,
Mr. French.

Elective Courses (General).

50. **I.** Plant Materials. — For juniors; seniors may elect. Aims to mak the student familiar with the distinguishing characters of trees, shrubs and wood vines used in ornamental plantings; together with the propagation and care the same.
3 class hours. 2 2-hour laboratory periods, credit,
Professor Thompson.

51. **III.** Plant Materials. — For juniors; seniors may elect. A continua tion of Course 50, taking up the field uses of trees, shrubs and woody climber their natural habitats, soils and plant associations, with a view to supplying to th students in landscape gardening and floriculture a knowledge of the species an varieties used in ornamental planting. Frequent practicums and field excursions
3 class hours. 2 2-hour laboratory periods, credit, 5
Professor Thompson.

Prerequisite, Horticulture 50.

75. **III.** Horticulture Review. — Required of all seniors majoring in th Division of Horticulture. Designed to correlate the various branches of plan science and horticultural practice.
1 lecture hour, 1 conference period. Credit, 2
Professor Waugh.

Landscape Gardening.

Professor Waugh, Assistant Professor Harrison, Assistant Professor Quinlan.

The purposes of the courses are: (1) To train men for the profession in all it branches. As a rule graduates should first enter the employ of established land scape architects, nurserymen or park superintendents, and after an apprenticeshi several years those who have the requisite technical and business ability may set for themselves. (2) To train men for public-service work in national, State d municipal parks and forests. (3) To train men for country planning, this action being exercised through various public institutions and organizations.) To train teachers and extension workers in lines of landscape gardening and ric improvement. (5) To give a broad and liberal general education stressing e fundamental principles of art.

The department has large, well-lighted drafting rooms, with necessary equipent, such as planimeters, eidograph, pantograph, blueprinting outfit, etc.; and complete outfit of surveying instruments, including transits, levels, plane tables, ismatic compasses, hand levels, etc. The college campus presents an unusually od collection of the plant materials used in landscape gardening.

Drawing.

Required Courses.

25. **I.** Free-hand Drawing. — For sophomores; juniors and seniors may ect. Lettering; free-hand perspective; sketching from type models, leaves, wers and trees, houses, etc.; laying flat and graded washes in water colors; ter-color rendering of leaves, flowers and trees.

4 2-hour laboratory periods, credit, 4.
Assistant Professor Quinlan.

26. **II.** Mechanical Drawing. — For sophomores; juniors and seniors may ect. Inking exercises; geometric problems; projection; intersections; isometric; ades and shadows; parallel; angular and oblique perspective; perspective drawg of buildings. Students should have preparation in plane and solid geometry.

3 2-hour laboratory periods, credit, 3.
Assistant Professor Quinlan.

27. **III.** Topographical Drawing. — For sophomores; juniors and seniors ay elect. Conventional signs and mapping in ink; conventional coloring and ap rendering in water colors.

4 2-hour laboratory periods, credit, 4.
Assistant Professor Quinlan.

erequisite, Drawing 26.

30. **I.** Elementary Design. — For sophomore women. Offered for the ar 1926–27.

3 2-hour laboratory periods, credit, 3.
Assistant Professor Quinlan.

Landscape Gardening.

Elective Courses.

50. **I.** Mapping and Topography. — For juniors. Reconnoissance surveys d mapping, with special reference to the methods used in landscape gardening. ust be followed by Course 51.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, 5.
Assistant Professor Harrison.

erequisites, Mathematics 26 and 27, Drawing 25, 26 and 27.

51. **II.** Elements of Landscape Gardening. — For juniors. Detailed study selected designs of leading landscape gardeners; grade design, road design, etc.

3 3-hour laboratory periods, credit, 4.
Assistant Professor Harrison.

erequisite, Landscape Gardening 50.

52. **III.** General Design. — For juniors. Field notes; examination of co[mpleted] works and those under construction; design of architectural details; writ[ten] reports on individual problems.

2 2-hour laboratory periods; 2 3-hour laboratory periods, credit, .
Assistant Professor Harrison

Prerequisites, Landscape Gardening 50 and 51, and either plant materials (Hor[ti]culture 50 and 51) or advanced mathematics.

75. **I.** Theory of Landscape Art. — For seniors and graduates. The g[en]eral theory and applications of landscape study, including a brief history of the a[rt].
3 class hours. Credit .
Professor Waugh

76. **I.** Civic Art. — For seniors. The principles and applications of mod[ern] civic art, including city planning, city improvement, village improvement a[nd] rural improvement, with special emphasis upon country planning. Must be f[ol]lowed by Course 77.

3 3-hour laboratory periods, credit .
Assistant Professor Quinlan

Prerequisite, Landscape Gardening 52.

77. **III.** Country Planning. — For seniors. As stated under Course .
3 3-hour laboratory periods, credit .
Professor Waugh

Prerequisite, Landscape Gardening 76.

78. **I.** Architecture (1926–27). — Alternates with Course 79. For juni[ors] and seniors. The history of architectural development, the different historic typ[es], with special reference to the underlying principles of construction and des[ign] and their relations to landscape design. Illustrated lectures, field trips, study [of] details including preparation of plates.
3 class hours. Credit, .
Assistant Professor Harrison

79. **I.** Construction and Maintenance (1927–28). — Alternates w[ith] Course 78. For juniors and seniors. Detailed instruction in methods of constr[uc]tion and planting in carrying out plans, in organization, reporting, accounti[ng], estimating, etc.; maintenance work in parks and on estates, its organizati[on], management, cost, etc.
3 class hours. Credit, .
Assistant Professor Harrison

80. **II.** Theory of Design. — For seniors. Lectures; exercises in p[ure] design in two and three dimensions; conventional designs; modeling.
3 3-hour laboratory periods, credit, .
Professor Waugh.

Prerequisite, Landscape Gardening 52.

81. **II.** Estate Design. — For seniors. Grading and planting plans; gard[en] designs and planting.
3 3-hour laboratory periods, credit, .
Assistant Professor Harrison.

82. **III.** Park Design. — For seniors.
3 3-hour laboratory periods, credit, .
Assistant Professor Harrison.

Pomology.

Professor Sears, Professor Van Meter, Assistant Professor Drain, Mr. French, Mr. Roberts.

The object of the course is to give a training which shall be thoroughly practical ıd yet scientific. This should fit men to enter the field of practical fruit growing, it will furnish an excellent foundation for further study.

The department has 50 acres in fruit plantations. The apple orchards comprise ›out 35 acres, and there are blocks of pears, peaches, plums and cherries. In ıall fruits there are plantings of strawberries, raspberries, blackberries, currants ıd blueberries. There are four vineyards, with a total area of 5 acres, in which e leading varieties and the principal types of pruning and training are repre-nted. In these plantations are 50 varieties of grapes, representing three native nerican species and many hybrids; 20 varieties of peaches; 20 varieties of pears; of plums, including five species and many hybrids; and 100 varieties of apples.

The department has an excellent equipment of spraying and dusting machinery, cluding various styles and sizes of power sprayers, and many types of barrel ımps and smaller sprayers. There is also an excellent assortment of orchard ols, including a tractor, plows, harrows, fertilizer sowers, etc.

Fisher Laboratory is one of the best planned and equipped packing and storage ›uses in the United States. It includes six refrigerated rooms; four storage oms not refrigerated; one large laboratory room and one classroom, besides nple storage room for fruit packages and equipment. The equipment for the ıilding itself includes four types of apple sizers; packing tables and box and bar-l presses of various types, besides all kinds of packages and the smaller equip-ent necessary for thoroughly modern work in grading and packing fruit. The ›partment is equipped with lockers and with pruning and other tools for the use students in laboratory work, which is made a leading feature in all the courses pomology.

Elective Courses.

50. I. Practical Pomology. — For juniors; seniors may elect. A study of ıe general principles of the growing of fruits, dealing with such questions as lection of site, soils, windbreaks, laying out plantations, choice of nursery stock, 'uning, culture of orchards, orchard fertilizers, cropping orchards, etc. Text-›oks, lectures, and reference books; field and laboratory exercises.
class hours. 1 2-hour laboratory period, credit, 3.
Professor Sears and Mr. Roberts.

rerequisite, Horticulture 27.

51. II. Practical Pomology. — For juniors; seniors may elect. As stated ıder Course 50.
class hours. 1 2-hour laboratory period, credit, 3.
Professor Sears and Mr. Roberts.

rerequisite, Pomology 50.

52. III. Small Fruits. — For juniors; seniors may elect. A study of the owing of small fruits, including raspberries, blackberries, strawberries, currants, ueberries and grapes, dealing with such questions as their propagation, select-g a site for the plantation, soils, fertilizers, pruning, harvesting, marketing, etc.
class hours. 1 2-hour laboratory period, credit, 3.
Professor Sears and Mr. Roberts.

rerequisite, Horticulture 27.

54. II. Systematic Pomology. — For juniors; seniors may elect. A study varieties of fruits including identification, nomenclature, relationships and assification. This course is advised but not required of candidates for the varsity uit judging team. Lectures, textbooks, laboratory and field exercises.
class hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Drain.

rerequisite, Horticulture 27.

75. **I.** Systematic Pomology. — For seniors. A continuation of Course 5 with special reference to nursery variety certification, variety study of pear grapes, plums, cherries, strawberries, raspberries, blueberries and blackberries.
1 class hour. 2 2-hour laboratory periods, credit,
Assistant Professor Drain.

Prerequisite, Pomology 54.

76. **II.** Orchard Management. — For seniors. This course will consid the more important problems in connection with the organization and managemen of a fruit farm. Specialization and diversification and the place of each of th common fruit crops on the farms of Massachusetts will be studied in relation to th distribution of labor and income. The combination of fruit growing with oth lines of farming will be discussed in connection with conditions in this State ar combinations in successful operation will be studied. The course is intended bring principles learned in the previous years in college to bear upon the particul problems of the fruit grower.
2 class hours. 1 2-hour laboratory period, credit,
Professor Van Meter.

Prerequisite, Pomology 51.

77. **I.** Commercial Pomology. — For seniors. The picking, handling, sto ing and marketing of fruits, including a discussion of storage houses, fruit package methods of grading and packing. Especial emphasis is placed upon laborato and field work, where the student is given actual practice in the picking and pac ing of most of the principal fruits.
1 class hour. 2 2-hour laboratory periods, credit,
Mr. Roberts.

Prerequisite, Pomology 51.

78. **III.** Spraying. — For seniors. A study of (*a*) spraying materials, the composition, manufacture and preparation for use; the desirable and objectio able qualities of each material, formulas used, cost, tests of purity. (*b*) Sprayi machinery, including all the principal types of pumps, nozzles, hose and vehicle their structure and care. (*c*) Orchard methods in the application of the vario materials used, with the important considerations for spraying each fruit and f combating each orchard pest. This course is designed especially to familiarize th student with the practical details of actual spraying work in the orchard. Spra materials are prepared, spraying apparatus is examined and tested, old pumps a overhauled and repaired, and the actual spraying is done in the college orchar and small-fruit plantations.
1 class hour. 2 2-hour laboratory periods, credit,
Assistant Professor Drain.

Prerequisite, Pomology 51 or 79.

79. **II.** General Pomology. — For seniors; juniors may elect. Planned t meet the needs of students who cannot devote more than one term to the subje but who want a general knowledge of fruit growing. Consists of lectures an laboratory exercises on such topics as choosing the locations, kinds and varieti of fruits to grow, securing and setting the plants, care and cultivation, prunin spraying, pests, harvesting and storing.
2 class hours. 1 2-hour laboratory period, credit,
Mr. French.

80. **I.** Seminar. — For seniors majoring in pomology. Advanced study o problems relating to the business of fruit growing. Each student is assigned major problem in lines of work in which he is particularly interested. He pursu his studies both by reading and research, and the materials obtained will b worked into theses which are presented to the seminar for discussion. No lectur are given, but seminar meetings are held for one period each week.
1 class hour. Credit,
The Department.

81. **II.** Seminar. — For seniors majoring in pomology. A continuation of urse 80. One seminar meeting each week.
lass hour. Credit, 1.
The Department.

82. **III.** Seminar. — For seniors majoring in pomology. A continuation of urse 81. One seminar meeting each week.
lass hour. Credit, 1.
The Department.

Vegetable Gardening.

Professor Waugh, Assistant Professor Snyder and Mr. Stout.

The courses in Vegetable Gardening are designed for students who wish to enter nmercial vegetable growing, the seed business, or professional work, such as ching or experimental work. Each of these fields offers wide possibilities and advancement of vegetable production will depend upon the number and quality the men trained along these lines.

The department has ten acres of land, 3,800 sq. ft. of greenhouse space, and 150 bed sash, all of which are used to provide laboratory facilities. Part of this iipment is used for the non-commercial laboratory work, such as the students' dens and the type and variety garden, while the remainder is devoted to comrcial laboratory work.

In addition the department maintains at Waltham, Massachusetts, the Market rden Field Station. Here the experimental and extension work of the departnt is carried on.

Elective Courses.

50. **III.** General Vegetable Gardening. — For juniors; seniors may elect. general course for those students who desire a general knowledge of agriculture, do not care to spend the time for extreme specialization. Designed to teach fundamentals of vegetable growing so they may be applied (1) to the growing vegetables commercially as a cash crop with other types of agriculture, (2) to growing of vegetables in the home garden, (3) to agricultural teaching in secdary schools, and (4) to professional agricultural work other than teaching.
lass hours. 2 2-hour laboratory periods, credit, 5.

52. **II.** Practical Vegetable Gardening. — For juniors; seniors may elect. urses 52 and 53 are designed for those students who wish to obtain a knowledge vegetable growing in order that they may apply this to the successful commercial duction of vegetables, or to become fitted for professional work such as teaching l research work. The course begins with a consideration of vegetables as a food, part they play in the food supply of the city, State, or nation, and Massachuts' part in this type of food production, followed by a study of the fundamentals vegetable gardening. Deals with such questions as the selection of a location; ls, manures and fertilizers, green manures and cover crops; seeds and seeding; nting, tillage, irrigation; control of insects and diseases. Includes a detailed dy of the cultural requirements of the common vegetable crops, and the prinles of rotation and double cropping. Text and reference books. Laboratory l field exercises.
3 lass hours. 2 2-hour laboratory periods, credit, 5.

Prerequisites, Horticulture 26, Agronomy 75.

53. **III.** Practical Vegetable Gardening. — For juniors; seniors may ect. As stated under Course 52.
3 lass hours. 2 2-hour laboratory periods, credit, 5.

Prerequisite, Vegetable Gardening 52.

75. **I.** Types and Varieties. — For seniors. Includes the systematic stud of types, varieties and strains of the leading vegetable crops; exhibiting an judging of vegetables; determination of quality in vegetables; seed growin variety improvement, rogueing, seed harvesting, curing and storing.
3 class hours. 2 2-hour laboratory periods, credit,

Prerequisite, Vegetable Gardening 53 or 50.

76. **II.** Vegetable Forcing. — For seniors. A study of types, materia construction, location, arrangement, capacity and cost of greenhouses for growin vegetables. A brief consideration of the heating plant, — the type, installatio piping and management; also the study of greenhouse vegetable crops and the production as practiced by commercial growers.
3 class hours. 2 2-hour laboratory periods, credit,

Prerequisite, Vegetable Gardening 53 or 50.

77. **III.** Commercial Vegetable Growing. — For seniors. A consideratio of vegetable growing as a business. A study of this specialized type of farmin including places where developed, types, extent, economic importance, capitaliz tion, equipment and other fundamental problems of commercial vegetable garde ing. Students assist in the planning and operation of a typical market-gardenin area. Visits are made to market-gardening and truck-gardening farms.
3 class hours. 2 2-hour laboratory periods, credit,

Prerequisite, Vegetable Gardening 53 or 50.

DIVISION OF SCIENCE.

Professor Gordon.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inc sive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Botany.

Professor Osmun, Assistant Professor Clark, Assistant Professor McLaughlin, Assistant Professor Torre Assistant Professor Davis.

A knowledge of the principles of plant life is fundamental in agricultural educa tion. The required courses in botany are planned with this and the general edu cational value of the subject in view. Elective courses are of two types: (1) tho which have for their chief aim the direct support of technical courses in agricu ture and horticulture, and (2) those providing broader, more intensive training the science. Courses in the second group may lead, when followed by postgradua study, to specialization in the field. They also furnish excellent training for tho specializing in other sciences and in scientific agriculture. In all undergradua courses the relation of the science of botany to agriculture is emphasized.

The department occupies Clark Hall, a brick building 55 by 95 feet, two stori high, with basement and attic. The building has two lecture rooms with seatin capacity of 154 and 72, respectively; one seminar and herbarium room; larg laboratories for general and special work; and smaller rooms for advanced student A glass-enclosed laboratory for plant physiology adjoins the main building an provides unusual facilities for the study of phenomena of plant life. In additio a greenhouse 28 by 70 feet is connected with the building. This is for experiment work in plant pathology and physiology, and for growing plants needed for instru tion. The experiment station laboratories devoted to botanical research are i this building.

The laboratories and lecture rooms are of modern construction, finely lighte and equipped with compound and dissecting microscopes, microtomes, paraffin and drying ovens, physiological and other apparatus, and a large collection o charts. The herbarium contains about 20,000 sheets of seed plants and fern

)0 sheets of liverworts and mosses, and 25,000 specimens of fungi. Facilities equipment for the study of plant physiology and pathology are excelled in other institutions.

Required Courses.

. III. Introductory Botany. — For freshmen. Presents the seed plants plastic organisms molded by their environment. Also introduces the student nethods of identifying and classifying plants.
ass hours. 2 2-hour laboratory periods, credit, 4.
Assistant Professor Torrey.

5. II. Introductory Botany. — For sophomores. The anatomy and physigy of the seed plants (Phanerogamia).
ass hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Torrey.

requisite, Botany 3.

6. III. Morphology and Taxonomy of the Lower Plants (Cryptoiia). — For sophomores. Systematic study of typical forms of bacteria, algæ, gi, lichens, mosses, ferns. (Courses 3, 25 and 26 constitute a general elementary rse in botany, and are required of all students who major in science.)
ass hour. 3 2-hour laboratory periods, credit, 4.
Professors Osmun and McLaughlin.

requisite, Botany 25.

Elective Courses.

0. I. Diseases of Crops. — For juniors; seniors may elect. The lectures general and are taken by all who elect the course, but in order to permit students specialize on the diseases of crops most closely related to their majors or in ch they are most interested, the course is divided for lecture and laboratory k into the following sections: (I) diseases of truck and field crops; (II) dis-es of floricultural crops and ornamentals; (III) diseases of fruit crops; (IV) eases of shade and forest trees. One, two or three laboratory sections may be en.
 or 3 class hours. 1, 2 or 3 2-hour laboratory periods, credits, 2, 4 or 6.
Assistant Professor McLaughlin.

requisites, Botany 3 and 25.

1. II. Diseases of Crops. — For juniors; seniors may elect. As stated ler Course 50.
 or 3 class hours. 1, 2 or 3 2-hour laboratory periods, credits, 2, 4 or 6.
Assistant Professor McLaughlin.

requisite, Botany 50.

2. I. Systematic Mycology. — For juniors; seniors may elect. Morlogy and development of typical species representing the orders and families ungi; practice in identification, collection and preservation of fungi; study of tem of classification; collateral reading. A prerequisite of the senior course in at pathology, but open to all.
ass hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Davis.

requisite, Botany 26.

3. II. Systematic Mycology. — For juniors; seniors may elect. As stated ler Course 52.
lass hour. 2 2-hour laboratory periods, credit, 3.
Assistant Professor Davis.

requisite, Botany 52.

54. **III.** Systematic Mycology. — For juniors; seniors may elect. As stated under Course 52.
1 class hour. 2 2-hour laboratory periods, credit,
Assistant Professor Davis.

Prerequisite, Botany 53.

55. **III.** Plant Histology. — For juniors; seniors may elect. Comparative study of the tissue of plants; training in histological methods, including the use of precision microtomes, methods of killing, fixing, sectioning, staining and mounting; collateral reading and conferences. This course offers valuable training in preparation for further work in botany.
5 2-hour laboratory periods, credit,
Assistant Professors McLaughlin, Torrey and Davis.

Prerequisite, Botany 3 and 25.

58. **I.** Systematic Botany of the Higher Plants (1926–27). — For juniors and seniors. An intensive study of gymnosperms and angiosperms. Lectures deal with the interrelations of the flowering plants and with their ecology, distribution and economic importance. Laboratory work consists of a critical study of types from the most important natural plant families. Particular emphasis is laid on the flora of Massachusetts. The department herbarium and greenhouses supply material of important tropical forms for study. Alternates with Course 61.
2 class hours. 1 2-hour laboratory period, credit,
Assistant Professor Torrey.

59. **II.** Systematic Botany of the Higher Plants (1926–27). — For juniors and seniors. As stated under Course 58. Alternates with Course 62.
2 class hours. 1 2-hour laboratory period, credit,
Assistant Professor Torrey.

60. **III.** Systematic Botany of the Higher Plants (1926–27). — For juniors and seniors. As stated under Course 58. Alternates with Course 63.
2 class hours. 1 2-hour laboratory period, credit,
Assistant Professor Torrey.

61. **I.** The Comparative Anatomy of Green Plants (1927–28). — For juniors and seniors. In the lectures an intensive study is directed to the comparative anatomy of green plants from the evolutionary standpoint. Particular emphasis is laid upon the woody forms both living and extinct. Of the latter, the department is fortunate in possessing excellent sets of micro-preparations and lantern slides. Alternates with Course 58.
2 class hours. 1 2-hour laboratory period, credit,
Assistant Professor Torrey.

62. **II.** The Comparative Anatomy of Green Plants (1927–28). — For juniors and seniors. As stated under Course 61. Alternates with Course 59.
2 class hours. 1 2-hour laboratory period, credit,
Assistant Professor Torrey.

63. **III.** The Comparative Anatomy of Green Plants (1927–28). — For juniors and seniors. As stated under Course 61. Alternates with Course 60.
2 class hours. 1 2-hour laboratory period, credit,
Assistant Professor Torrey.

75. **I.** Plant Pathology. — For seniors. Comprehensive study of diseases of plants; training in laboratory methods and technique, including culture work and artificial inoculation of hosts; miscellaneous diagnosis; study of literature and representative life histories of pathogens. Prepares for civil service, experiment station and college work.
1 class hour. 4 2-hour laboratory periods, credit,
Professors Osmun and Davis.

Prerequisite, Botany 54.

76. **II.** Plant Pathology. — For seniors. As stated under Course 75.
class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Davis.

:erequisite, Botany 75.

77. **III.** Plant Pathology. — For seniors. As stated under Course 75.
class hour. 4 2-hour laboratory periods, credit, 5.
Professors Osmun and Davis.

:erequisite, Botany 76.

78. **I.** Plant Physiology. — For seniors. Study of the factors and contions of (*a*) Plant Nutrition, including the taking up of water and mineral bstances, the assimilation of carbon and nitrogen, and the release of energy ıe to the processes of dissimilation; (*b*) Plant Growth, including the influence internal and external factors on growth, the development of reproductive and ›getative organs; (*c*) Plant Movements, including those due to the taking up of ater, and those movements of both motile and fixed forms in response to external imuli. Weekly conferences are held at which students report on assignments to iginal sources in the literature.
class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor Clark.

rerequisites, Botany 26 and Chemistry 51.

79. **II.** Plant Physiology. — For seniors. As stated under Course 78.
class hours. 1 or 3 2-hour laboratory periods, credit, 3 or 5.
Assistant Professor Clark.
rerequisite, Botany 78 for the 5-credit course, Botany 25 for the 3-credit course.

80. **III.** Plant Physiology. — For seniors. As stated under Course 78.
class hours. 1 or 3 2-hour laboratory periods, credit, 3 or 5.
Assistant Professor Clark.

rerequisite, Botany 79.

General and Agricultural Chemistry.

ofessor Lindsey, Professor Chamberlain, Professor Peters, Assistant Professor Serex, Dr. Butler.

In teaching the courses in chemistry, emphasis is laid on both their educational ıd their vocational value. The courses in the freshman year deal with fundaental principles, and give the student such an understanding of the subject as ill enable him to apply it in farm practice. The more advanced courses, includg quantitative analysis, organic, physiological and physical chemistry, are r those who intend to become teachers and workers in the allied sciences, or who ›sire to follow agricultural chemistry as a vocation. Advanced training is given 7 means of postgraduate courses (see Graduate School).

Those completing the undergraduate courses are fitted for positions in the agriıltural industries, — fertilizer, feed and insecticide manufacture, — as well as in her lines of industry, and in the State experiment stations, in commercial laboraries, and in high school teaching. Postgraduate students are prepared for posiɔns as teachers in colleges, and for more advanced positions in industry and in e experiment stations.

The new Goessmann Chemistry Laboratory was opened for classes in September,)24.

Required Courses.

The freshman work consists of two distinct parts: Courses 1 and 2 contain more ›urs and are for those who have not had chemistry in the secondary schools, and ɔurses 4 and 5 are for those who have presented chemistry for entrance. Both oups of courses bring the student out at the same point. It is obviously to the lvantage of the student to take a course in chemistry in high school and thus ›viate the extra hours of Courses 1 and 2 in the freshman year.

1. I. General Chemistry. — For freshmen. This course is for those student who do not present chemistry for entrance and who begin the subject in college It presents an introduction to the fundamental chemical laws, together with study of the typical acid- and base-forming elements and their compounds.
3 class hours. 2 2-hour laboratory periods, credit, 5
Dr. Butler.

2. II. Agricultural Chemistry. — For freshmen. A continuation o Course I. A study of the common elements. Special emphasis is placed on the ap plication of the fundamental chemical laws particularly in connection with agricul ture and every-day life. Substances important in agriculture, such as superphosphate ammonium sulfate, muriate and sulfate of potash, Paris green, arsenate of lead Bordeaux mixture, lime-sulfur and emulsions, are prepared in the laboratory an studied in detail in the classroom; some of the substances prepared may be analyzed Particular attention will be given to a study of the composition, properties an reactions of soils. Approximate quantitative determinations of a number o constituents of soils and fertilizers will be made.
3 class hours. 2 2-hour laboratory periods, credit, 5
Dr. Butler.

4. I. Advanced General Chemistry. — For freshmen. A review of gen eral chemistry centered, for the most part, about the laboratory work. Text books, Holmes' "General Chemistry," and Peters' "The Preparation of Sub stances Important in Agriculture." The laboratory work takes the syntheti form. Substances of agricultural importance are prepared in quantity and studie in detail by the student. These include ammonium sulfate, superphosphate muriate and sulfate of potash, arsenate of lead, Paris green, Bordeaux mixture lime-sulfur and emulsions.
2 class hours. 2 2-hour laboratory periods, credit, 4
Professor Peters.

Prerequisite, Entrance Chemistry.

5. II. Inorganic Agricultural Chemistry. — For freshmen. A study o the chemical composition, properties and reactions of soils, fertilizers, fungicide and insecticides. The laboratory work is divided into three parts: (*a*) qualita tive examination of soil, plant ash and superphosphate; (*b*) approximate quan titative determination of moisture, ash, carbonic acid, phosphoric acid, potash nitrogen, etc., in farm crops, soils and fertilizers; (*c*) special work on retention o salts by soil, leaching of lime from the soil by carbonated water, etc.
2 class hours. 2 2-hour laboratory periods, credit, 4
Assistant Professor Serex.

25. II. Qualitative Analysis. — *Basic.* — For sophomores. The systemati analysis of metallic salts, presented from the ionic viewpoint. A close study o the tests used in the separation and identification of the metals, and the applicatio of these tests to unknown mixtures. Text, Medicus' "Qualitative Analysis," with Stieglitz's "Qualitative Analysis" and Gooch and Browning's "Qualitativ Analysis" for reference. This course should be taken by all intending to follow chemistry as a vocation.
2 class hours. 2 2-hour laboratory periods, credit, 4
Assistant Professor Serex.

Prerequisite, Chemistry 2 or 5.

26. III. Qualitative Analysis. — *Acidic.* — For sophomores. A continua tion of Course 25.
1 class hour. 2 2-hour laboratory periods, credit, 3
Assistant Professor Serex.

30. II. Organic Agricultural Chemistry. — For sophomores; juniors and seniors may elect. Embraces the study of the most important groups of organic compounds of plants and animals, the composition of plants, the chemistry of

nt growth, plants as food and as industrial material, the composition of animals, chemistry of digestion, also the study of some of the products related to plants l animals, such as milk, butter, cheese, sugar and alcohol. The treatment of subject is general, avoiding (so far as possible) complicated chemical facts and ationships, and endeavoring simply to make the student acquainted with the eral chemistry of plants and animals and agricultural processes and products. xtbook: Chamberlain's "Organic Agricultural Chemistry."

lass hours. 2 2-hour laboratory periods, credit, 5.

Professor Chamberlain.

Elective Courses.

51. **I.** Organic Chemistry. — For juniors; seniors may elect. Consists of ystematic study, both from texts and in the laboratory, of the more important npounds in the entire field of organic chemistry. Especial attention is given to se compounds which are found in agricultural products or are manufactured m them. These include alcohols, acids, esters, fats, carbohydrates and proteins. e work forms a foundation for courses in physiological chemistry and agricul al analysis, and is especially planned for those majoring in chemistry or the er sciences. Textbook: Chamberlain's "Organic Chemistry." Those elect- Course 51 are expected to elect Course 52.

lass hours. 2 3-hour laboratory periods, credit, 6.

Professor Chamberlain.

rerequisites, Chemistry 2 or 5, and Chemistry 26 for those majoring in chemistry.

52. **II.** Organic Chemistry. — For juniors; seniors may elect. A contin- ion of Course 51.

lass hours. 2 3-hour laboratory periods, credit, 6.

Professor Chamberlain.

53. **III.** Organic Chemistry. — For juniors; seniors may elect. A contin- ion of Courses 51 and 52, dealing principally with compounds of the benzene ies.

lass hours. 2 3-hour laboratory periods, credit, 6.

Professor Chamberlain.

61. **I.** Quantitative Analysis. — For juniors; seniors may elect. The rse includes the gravimetric determination of chlorides, sulfates, iron, the volu- tric analysis of acids and bases, and the dichromate method for iron. Text: ith's "Quantitative Chemical Analysis."

lass hour. 2 4-hour laboratory periods, credit, 5.

Professor Peters.

requisite, Chemistry 25. Course 26 is prerequisite for those majoring in chemistry.

62. **II.** For juniors; seniors may elect. A continuation of Course 61. A dy of potassium permanganate as a volumetric reagent; limestone is analyzed; sphorus is determined in soil; and the perchlorate method for potash is carried . Analytical problems are a part of the work.

lass hours. 2 4-hour laboratory periods, credit, 6.

Professor Peters.

63. **III.** For juniors; seniors may elect. A continuation of Course 62. The dy of the oxidation reactions of iodin, and precipitating reactions of thiocyanate; is green and lead arsenate are analyzed. The work closes with water analysis. means of assigned readings students are shown the importance of library work. "Methods of the American Public Health Association" is used as a supplementary t.

lass hour. 2 4-hour laboratory periods, credit, 5.

Professor Peters.

75. **I.** Physical Chemistry. — For seniors. A study of the fundamental theories and laws of physical chemistry together with laboratory work which includes the important methods of physicochemical measurements.
3 class hours. 6 laboratory hours, credit, 6.
Assistant Professor Serex.

Prerequisite, Chemistry 61.

80. **I.** Physiological Chemistry. — For seniors. Supplementary to Courses 51, 52 and 53. To those who expect to take up scientific work in microbiology, botany, agronomy, animal husbandry, etc., and who have had Courses 51, 52 and 53, it gives acquaintance with the chemistry of the physiological processes in plants and animals, by means of which some of the important organic compounds studied in Courses 51, 52 and 53 are built up in the living organism or are used as food by it. In the lectures the study of food and nutrition as related to both human and domestic animals is the principal subject. In the laboratory experimental studies are made of the animal body and the processes and products of digestion, secretion and excretion.
3 class hours. 2 2-hour laboratory periods, credit, 5.
Dr. Butler.

81. **II.** Food Analysis. — For seniors. Primarily for the study of milk and butter analytically. May also include the analyses of other food stuffs for nutritive value or for impurities.
1 class hour. 2 4-hour laboratory periods, credit, 3.
Dr. Butler.

Prerequisite, Chemistry 61.

86. **II.** Review of General Chemistry. — For seniors. Primarily for students majoring in chemistry; others may elect by permission from the instructor. A knowledge of physical chemistry is desirable. The review of general chemistry is largely theoretical, using as text Alexander Smith's "Introduction to Inorganic Chemistry," or Mellor's "Modern Inorganic Chemistry." Some subjects may be enlarged by special lectures, such as: atomic structure, Werner's co-ordination theory, crystal structure as shown by X-rays.
3 class hours. Credit, 3.
Professor Peters.

87. **III.** History of Chemistry. — For seniors. An historical and biographical study of chemistry and chemists. The aim of the course is: (1) to give the student a comprehensive view of the science as a whole, through a study of the development of new ideas and the establishment of new theories and laws; and (2) to arouse an enthusiastic interest in the subject and an appreciation of the true spirit of scientific research through a sympathetic presentation of the work and lives of the great chemists who have been the creators of the chemistry of to-day. The course will consist of lectures, supplemented by systematic correlated reading and the preparation of reports or essays.
3 class hours. Credit, 3.
Professor Chamberlain.

90. **II.** Special Work in Chemical Problems. — For seniors. An assignment is made to each student and he is expected to learn how research is done. The problem may be in analytical, general, agricultural or industrial chemistry and is to be continued for two terms.
1 class hour. 8 laboratory hours, credit, 5.
Professor Peters.

91. **III.** Special Work in Chemical Problems. — For seniors. As stated under Course 90.
1 class hour. 8 laboratory hours, credit, 5.
Professor Peters.

?. **II.** Special Work in Organic Chemistry. — For seniors. In this se, as in Courses 90 to 97, the student may give his attention primarily to one of chemical study for the purpose of becoming acquainted with methods search. To those whose tastes and interests are in connection with the organic lems of agricultural chemistry, many subjects of study present themselves, ng which may be mentioned: proteins, carbohydrates, fats, organic nitrogenous pounds in fertilizers and soils and their relation to plants, the commercial luction of alcohol from agricultural products, dyes, synthetic medicines, umes, etc.

iss hour. 8 laboratory hours, credit, 5.
Professor Chamberlain.

equisites, Chemistry 51, 52, 53 and 80.

?. **III.** Special Work in Organic Chemistry. — For seniors. As stated er Course 92.

iss hour. 8 laboratory hours, credit, 5.
Professor Chamberlain.

equisite, Chemistry 92.

?. **II.** Special Work in Physical Chemistry. — For seniors. The field of cultural chemistry offers many problems that have been attacked through the hods of physical chemistry; such, for example, are the hydrolysis of salts and inerals and the absorption of salts and fertilizers by soils. For students insted in colloid chemistry a short course in the fundamentals may be pursued his term with the ultimate object of selecting a problem along this line. This se is designed to familiarize the student with the literature on a special topic, to give an insight into the methods of research. Each student selects one of work and follows it through the course, repeating some of the original work.

iss hour. 8 laboratory hours, credit, 5.
Assistant Professor Serex.

equisite, Chemistry 75.

?. **III.** Special Work in Physical Chemistry. — For seniors. As stated er Course 94.

iss hour. 8 laboratory hours, credit, 5.
Assistant Professor Serex.

equisite, Chemistry 94.

?. **II.** Special Work in Physiological and Food Chemistry. — For ors. An opportunity for those so interested to pursue the study of some physioal or food problem. This course is intended to familiarize the student with nature of research under the careful supervision of the instructor. The prob of physiological chemistry are of a varied and interesting character.

iss hour. 8 laboratory hours, credit, 5.
Dr. Butler.

equisite, Chemistry 80.

?. **III.** Special Work in Physiological and Food Chemistry. — For ors. As stated under Course 96.

iss hour. 8 laboratory hours, credit, 5.
Dr. Butler.

equisite, Chemistry 80.

Entomology.

Professor Fernald, Professor Crampton, Assistant Professor Alexander, Mr. Farrar.

ntroductory Course 26 presents a comprehensive view of the relation of insects nan, particularly as crop pests. The most important pests are carefully studied, ther with the methods for their control. Courses 50 and 51 are arranged for ial study of the pests of any one line of agricultural or horticultural occupation, cted by the student according to his plan of future work, with the intent of making him thoroughly familiar with the pests he will meet in his selected wo after graduation, and the means of controlling them. The remaining courses a for the training of men as State or experiment station entomologists; for tho going into the care of trees, etc., on estates, or for cities and towns; and as e tomological experts, for which the demand has been very large.

Fernald Hall provides excellent lecture rooms and laboratories for this depar ment. The laboratories are provided with individual desks, equipped with micr scopes and all needed apparatus of all kinds. Dissecting microscopes, binocula microtomes, photographic apparatus, glassware and reagents are available for u and electric light and gas are connected with each desk. Two laboratories, one f juniors and seniors, the other for graduate students, are thus equipped. A depar ment library containing all the more important works on insects, supplement by others on the subject in the main library, and by the private libraries of t professors, make available more than 25,000 books and pamphlets on this subje In addition, all the current magazines are received and their files are accessible every one. A card catalogue giving references to the published articles on differe insects contains about 65,000 cards, and is probably the largest index of its ki in the world. Spray pumps, nozzles and spraying appliances of all kinds are use in various parts of the courses, and a large collection of insecticides is acc sible for study. Photographic rooms are specially prepared for the photograp of insects, and the greenhouses, gardens, orchards and the grounds of the colle provide wide opportunities for the study, under natural conditions, of ins pests.

Course 26 is required of sophomores in the Divisions of Horticulture and Scien and may be elected by students in the other Divisions.

26. **I.** General and Economic Entomology. — For sophomores; juni and seniors may elect. For students who desire some knowledge of insects, b who cannot give more than one term to the subject; also an introduction to t later courses for those who intend to follow entomology further. Touches brie upon the structure of insects so far as this is needed for such a course; deals w metamorphosis, classification to the larger groups, and discusses the most importa methods and materials used for control. The greater part of the time is devot to special study of the most important insect pests, particularly of New Englar showing their modes of life, the injuries they cause, and the best methods of co trol. In this way the most serious pests of fruit trees, ornamental trees and shru market-garden and green-house pests, those attacking field crops and those affe ing animals and man, are treated.

4 class hours. Credit,

Professor Fernald.

28. **III.** General and Economic Entomology. — For sophomores; juni and seniors may elect. Three class-room exercises to about May 1; thereaft three field exercises per week. In the field the work of insects found will be studi and a collection of insects made. Methods of collecting, preparing and mounti insects for collections will be taught. In the class room until about May 1, studi preparatory to the field work will be given. Class limited to 30 members.

3 class hours to about May 1; thereafter,

3 2-hour laboratory periods, credit,

The Department.

Prerequisite, Entomology 26.

50. **I.** Pests of Special Crops. — For juniors; seniors may elect. F students not majoring in entomology. The laboratory work is largely individu in this term. Accordingly, students majoring in subjects other than entomolog but who desire a more complete knowledge of the insects connected with th own major line of work, can obtain it here. A student majoring in floricultu for example, will devote his laboratory time to a careful study of the insects inju ing floricultural crops, learning how to recognize them and their work in th

ifferent stages, and the best methods for their control. Courses of this kind are vailable on the insects attacking field crops, market-garden crops, tree fruits, nall fruits, shade trees and shrubs, flowers, forest trees, the domesticated animals, ousehold pests and man. This work may be continued in the winter term also. See Course 51, **II.**)

3 2-hour laboratory periods, credit, 3.
Professor FERNALD.

rerequisite, Entomology 26.

51. **II.** PESTS OF SPECIAL CROPS. — As stated in Course 50, **I.** For students ot majoring in entomology. Those who were not able to take Entomology 50 i the fall may take it here. Those who took Entomology 50 in the fall have an pportunity to continue the work during this term also.

3 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

rerequisite, Entomology 26.

52. **I.** CLASSIFICATION OF INSECTS. — For juniors specializing in entomology. aboratory work on the identification and classification of insects of various roups.

2 2-hour laboratory periods, credit, 2.
Assistant Professor ALEXANDER.

ccompanying Entomology 53.

53. **I.** INSECT MORPHOLOGY. — For juniors specializing in entomology and r other juniors or seniors having the prerequisite. The lectures treat of the kternal and internal anatomy of insects, particularly those parts used in idenfication, a knowledge of which is needed, in the accompanying Course 52. In ie laboratory the external anatomy of the most important groups is studied, nphasizing the characters used in learning the names of insects, and to teach ie methods of using analytical keys.

class hours. 3 2-hour laboratory periods, credit, 5.
Professor CRAMPTON.

rerequisite, Entomology 26.

55. **II.** Continuation of Course 52, one-half term. Insects and their relation disease, one-half term.

4 2-hour laboratory periods, credit, 4.
Professors CRAMPTON and ALEXANDER.

56. **II.** PESTS OF SPECIAL CROPS. — For juniors majoring in entomology. idividual laboratory work on the most important insect pests of this country, id the preparation and presentation of bulletin material on them.

3 2-hour laboratory periods, credit, 3.
The DEPARTMENT.

57. **III.** CLASSIFICATION OF INSECTS. — Continuation of Course 55.

2 2-hour laboratory periods, credit, 2.
Assistant Professor ALEXANDER.

75. **III.** FOREST AND SHADE-TREE INSECTS. — For juniors; seniors may elect. ie lecture work deals with the principles and methods of controlling insects hich attack forests and forest products, shade trees, etc. The laboratory periods e devoted to a study of the more important species, their identification, biology d specific control measures. Field work supplements laboratory study if time rmits. One entire Saturday for field excursion also required.

class hour. 3 2-hour laboratory or field periods, credit, 4.
Assistant Professor ALEXANDER.

erequisites, Entomology 26; 52 and 53 desirable.

76. **I.** Advanced Entomology. — For seniors. Studies on insect bionom s; scale insects, their structure, habits, methods of mounting, identification, e .; studies of the animals not insects with which entomologists are expected to d l.
2 class hours. 3 2-hour laboratory periods, credit 3.
Professors Crampton and Alexande
Prerequisite, Entomology 55.

77. **II.** Advanced Entomology. — For seniors. Studies of the life hist y, habits and methods of control of the important insect pests of the United Sta s; recognition tests of these pests and an examination of the literature on th ; methods of bulletin preparation.
3 2-hour laboratory periods, credit 3.
Assistant Professor Alexande
Prerequisite, Entomology 76.

78. **III.** Advanced Entomology. — For seniors. Classification of ins ts and of their early stages; principles of classification, the use of literature on n-tomology and the preparation of bibliographies and indices; the enemies of inse s.
1 class hour. 3 2-hour laboratory or field periods, credi 4.
Professors Fernald, Crampton and Alexande
Prerequisite, Entomology 77.

79. **I.** Insecticides and their Application. — For seniors; juniors my elect. Lectures on the composition, preparation and methods of applicatio of insecticides; other control measures.
3 class hours. Credi 3.
Professor Fernal
Prerequisite, Entomology 26.

90. **II.** Evolution. — For seniors; juniors may elect. In order to den n-strate the universal scope and operation of the laws of evolution, the course n-cludes a brief sketch of the probable origin and evolution of matter as vie ed in the light of modern physical and chemical research; the evolution of the s ar system, leading to the formation of the earth; the changes in the earth, prep a-tory to the production of life; the physical and chemical basis of life; the prob le steps in the formation of living matter, and the theories concerning it; the ev u-tion of living things; the developmental history of man, and of the races of n n-kind; the evolution of human intelligence, languages, culture, institutions, ., and man's probable future in the light of his past development. Especial co d-eration is given to the factors of evolution, the basic principles of heredity, v a-tion and similar topics, with particular reference to their application to hu an welfare; and the recent contributions in the field of entomology to the adva e-ment of our knowledge of these fundamental principles are briefly reviewed.
3 class hours. Credi 3.
Professor Crampto

Courses in Beekeeping.

65. **III.** Introductory Beekeeping. — For juniors. A detailed stud of the normal behavior of the honey bee and the colony as a whole, followed l a study of such practical work of the apiary as is carried on in spring and sum r. In so far as possible the laboratory work parallels the lecture work, and both re made to follow the seasonal processes of the colony. Spring management, sw m control and the production and care of the honey crop are covered thoroug y. The course is designed to meet the needs of the horticulturist as well as thos of the honey producer, and should be followed by Course 85, I.
1 class hour. 2 2-hour laboratory periods, credi 3.
Mr. Farra

85. **I.** Introductory Beekeeping. — For seniors. A continuation of Co se 65 and a completion of the beekeeping year. Fall management, preparation or winter and wintering are studied in detail in lectures and laboratory work. Orig al

blems for student solution. It is highly advisable for those taking Course 65 take Course 85, and thus complete the annual cycle of beekeeping activity.
lass hours. 1 2-hour laboratory period, credit, 3.
Mr. Farrar.

36. II. Advanced Beekeeping. — For seniors. A study of the special blems with which the beekeeper deals. The diagnosis and control of the ious bee diseases, production of wax, sources of nectar, honey, bee anatomy l physiology, and marketing of the crop are some of the principal topics dissed. The course is designed for those who intend going into honey production ier as a principal occupation or as a side line. Field trips to commercial apiaries; oratory practice in queen rearing.
lass hours. 1 2-hour laboratory period, credit, 3.
Mr. Farrar.

Mathematics and Civil Engineering.

Professor Ostrander, Professor Machmer, Assistant Professor Moore, Mr. Boutelle.

'he work of the freshman year is required. It is intended to furnish the necesy drill and groundwork needed for many of the scientific and practical courses other departments. Thoroughness and accuracy are insisted upon. The adiced work in mathematics is taught from a practical standpoint, and many of applications to other subjects are given. The courses in surveying and civil ineering are given to furnish the groundwork for a professional career. Special phasis is given to the subjects bearing on highway construction and mainteice.

'or drawing, a room on the north side is used for the draughting. It has draught- tables, T squares, scales, etc., for twenty students. Vernier protractors, parl rules and steel T squares are available for precise work. A small room is oted to blueprinting.

n surveying, the department has a considerable number of chains and tapes, railroad compasses, a builder's level, two dumpy levels, two Y levels and old levels used for teaching the adjustments. Six transits are available for lent use. Two are provided with solar attachments. An omnimeter with ver- reading to ten seconds is available for geodetic work. A hand level, mining roid barometer, and prismatic compass are provided for reconnoissance work. et of Gilmor's needles and a Fairbanks' machine are used for cement testing.

Required Courses.

. I. Higher Algebra. — For freshmen. A brief review of radicals, quadc equations, ratio and proportion, and progressions; graphs, binomial theorem, etermined coefficients, summation of series, variation, continued fractions, deiinants, permutations and combinations, logarithms, theory of equations. tz and Crathorne's "College Algebra."
ass hours. Credit, 4.
Professors Machmer, Moore and Mr. Boutelle.

II. Higher Algebra. — As stated under Course 1. Required of all who ent solid geometry for entrance.
ass hours. Credit, 3.
Professors Machmer, Moore and Mr. Boutelle.

II. Solid Geometry. — For freshmen. Theorems and exercises on the perties of straight lines and planes, dihedral and polyhedral angles, prisms, mids and regular solids; cylinders, cones and spheres; spherical triangles the measurement of surfaces and solids. Wentworth and Smith's "Solid metry." Required unless accepted for admission.
ass hours. Credit, 3.
Professor Moore and Mr. Boutelle.

4. **II.** Mensuration and Computation. — For freshmen. A review of methods of computation, with special emphasis on short and abbreviated processes, together with methods of checking computations and of forming close approximations; use of slide rule. Also the graph, mensuration of plane and solid figures, weights and measures and elementary mechanism. Numerous practical problems are selected from such subjects as the following: the mathematics of woodworking; rough lumber; general construction; forestry methods in heights of trees; pulleys, belts and speeds; power and its transmission; dairying; agronomy; computation of areas from simple measurements.
2 class hours. Credit.
Professor Machmer and Mr. Boutelle.

5. **III.** Plane Trigonometry. — For freshmen. The trigonometric functions as lines and ratios; proofs of the principal formulas, transformations; inverse functions, use of logarithms; the applications to the solution of right and oblique triangles; practical applications.
3 class hours. Credit.
Professors Machmer, Moore and Mr. Boutelle.

Elective Courses.

26. **II.** Plane Surveying. — For sophomores; juniors and seniors may elect. The elements of the subject, including the adjustment and use of the usual instruments. Textbook and lectures.
3 class hours. Credit.
Professors Ostrander and Moore.

27. **III.** Plane Surveying. — For sophomores; juniors and seniors may elect. As stated under Course 26. Includes field work.
3 2-hour laboratory periods, credit.
Professors Ostrander and Moore.
Prerequisite, Mathematics 26.

50. **I.** Analytic Geometry. — For juniors; seniors may elect. A discussion of the geometry of the line, the circle, conic sections, and the higher plane curves. Fine and Thompson's "Co-ordinate Geometry."
3 class hours. Credit,.
Professor Machmer.
Prerequisites, Mathematics 1, 2, 3 and 5.

51. **II.** Differential and Integral Calculus. — For juniors; seniors may elect. A first course in the subject, with some of the more important applications. Granville's "Differential and Integral Calculus."
5 class hours. Credit,.
Assistant Professor Moore.
Prerequisites, Mathematics 1, 2, 3 and 5.

52. **III.** Integral Calculus. — For juniors; seniors may elect. A continuation of Course 51.
5 class hours. Credit,.
Assistant Professor Moore.
Prerequisite, Mathematics 51.

53. **II.** Elementary Structures. — For juniors; seniors may elect. An elementary course in roofs and bridges. Textbook and lectures.
3 class hours. 1 2-hour laboratory period, credit,.
Professor Ostrander.

75. **I.** Hydraulics and Sanitary Engineering. — For seniors; juniors may elect. Hydrostatics, theoretical hydraulics, orifices, weirs, pipes, conduits, water supply, hydraulic motors, sewers and sewage treatment. Textbook and lectures.
5 class hours. Credit,.
Professor Ostrander.

76. I. MATERIALS OF CONSTRUCTION. FOUNDATIONS AND MASONRY CON-RUCTION. — For seniors; juniors may elect. Textbook and lectures.
class hours. Credit, 5.
Professor OSTRANDER.

77. II. ROADS AND RAILROADS. — For seniors; juniors may elect. Topo-aphic and higher surveying, highway construction, earthwork, pavements and ilroad construction. Textbook and lectures.
class hours. Credit, 3.
Professor OSTRANDER.

78. III. ROADS AND RAILROADS. — For seniors; juniors may elect. As ated under Course 77.
3 2-hour laboratory periods, credit, 3.
Professor OSTRANDER.

rerequisite, Mathematics 77.

Microbiology.

Professor MARSHALL, Assistant Professor BRADLEY, Mr. FULLER, Miss GARVEY.

Three objectives are sought in the arrangement of the courses following: (1) In-oductory courses (50 and 51) needed in the general training of every college udent. (2) An introductory course followed by a specific course (as 80, 81, 82, 3), necessary to every student engaged in the Division of Agriculture, with which e specific course deals. (3) Introductory courses (50 and 51) followed by Courses 2, 75, 76 and 81, preparatory for students who are aiming to specialize in agricul-ral microbiology. (Courses 75, 76 and 81 are adapted to those having Courses) and 51 only, and are also adapted to those majoring in microbiology.)

The microbiological work is carried on in a building especially designed for it. here are 4 class laboratory rooms, 8 private laboratory rooms, 1 lecture room, incubator rooms, 3 sterilizing rooms, 3 hood rooms, 3 washing rooms, 3 inoculat-g rooms, 3 weighing rooms, an animal room, a photographic and dark room, a b-basement refrigerator room, a library and 4 office rooms.

The class laboratory rooms are so arranged that individual desks are available r student use. Hot and cold water and gas connections are convenient for each sk; high-pressure steam and electric connections are also available. The build-g is well lighted and of sanitary construction; all the walls are of brick, and the ilding is fireproof.

The library is equipped with such books and current periodicals as are useful in e conduct of bacteriological work and investigations. Twenty-four scientific agazines are available regularly.

There are incubators, both electric and gas, hot-air sterilizers, ordinary steam erilizers, autoclaves, an inspissator, blood-testing apparatus, vacuum apparatus, r-pressure apparatus, shaker, grinder, centrifugal machines, a water still of 5 llons per hour capacity, Hoskin's combustion furnace, a balopticon, complete icrophotographic equipment, microscopes, microtome, and such other apparatus, assware and chemicals as are needed for extensive and intensive work.

Required Course.

30. I and III. ELEMENTARY MICROBIOLOGY. — Required of sophomores major-g in Agriculture and Rural Home Life. Designed to make micro-organisms real d significant to the student who seeks some knowledge of their activities. An tempt is made to place them among living organisms, to demonstrate their wide stribution in nature and to indicate what they do. Some of the essential methods control and propagation are reviewed. Owing to the time limit, this course may regarded as an introductory survey course only.
6 laboratory hours, credit, 3.
Mr. FULLER.

33. III. PHYSIOLOGY. — For sophomores. Offered for the year 1926–27.
class hours. 1 2-hour laboratory period, credit, 4.
Miss GARVEY.

Elective Courses.

50. **I, II** and **III**. Introductory and General Microbiology. — F juniors; seniors may elect. Aims to provide elementary basis for microb studies and interpretation, to enable students to pursue special pertinent cour which will serve as supports in practical electives or majors, and to furnish stude with such material as will be valuable in understanding public health proble
2 class hours. 3 2-hour laboratory periods, credit,
Professor Marshall and Mr. Fuller

51. **II** and **III**. Morphological, Cultural and Physiological Mic biology. — For juniors; seniors may elect. Types of micro-organisms, tech of handling, methods of culture and functions of micro-organisms are consider This course is fundamental to all advanced and extended microbiological studi
10 laboratory hours, credit
Mr. Fuller
Prerequisite, Microbiology 30 or 50.

52. **III**. Advanced Morphological, Cultural and Physiological Mic biology. — For juniors; seniors may elect. Prepares for a more intimate kno edge of microbiological agricultural problems. To accomplish this object it s necessary to provide more advanced technique and methods of culture, toget r with a more extensive knowledge of micro-organisms and their functions.
10 laboratory hours, credit
Assistant Professor Bradley
Prerequisite, Microbiology 51.

60. **I**. Public Health. — For juniors; seniors may elect. Considers e relation of the human body to its environment in the maintenance of health d the production of disease. This study is based upon human anatomy and ph ology. The individual, as a member of society, governed by natural laws, is o of fundamental importance. A knowledge and an interpretation are sought f the usual agencies connected with health and disease, as air, water, sewage, d y products, foods, drugs, carriers, vaccines and their prophylactic means, biolog l products as diagnostic and remedial materials and public health practices v recognized. Diseases of public health significance are reviewed, their control c sidered and their social values discussed.
3 class hours. Credit 3.
Professor Marshall

61. **II**. Public Health. — For juniors; seniors may elect. As stated un r Course 60.
3 class hours. Credit 3.
Professor Marshall

62. **III**. Public Health. — For juniors; seniors may elect. As stated un r Course 60.
3 class hours. Credit 3.
Professor Marshall

75. **II**. Agricultural Microbiology. — For seniors; juniors may el t. This general comprehensive course is designed to cover in an elementary man r those subjects only which confront the student of general agriculture, — e microbiological features of air, water, sewage, soil, dairy, fermentations, f l, vaccines, antisera, microbial plant infections, methods and channels of infecti s, immunity and susceptibility, microbial infections of man and animals, method f control or sanitary and hygienic practices.
10 laboratory hours, credit 5.
The Department
Prerequisite, Microbiology 51.

76. **III.** Agricultural Microbiology. — For seniors; juniors may elect. s stated under Course 75.

10 laboratory hours, credit, 5.
The Department.

erequisite, Microbiology 75.

80. **II.** Soil Microbiology. — For seniors; juniors may elect. Such subcts as the number and development of micro-organisms in different soils; the ctors which influence their growth, food, reaction, temperature, moisture and ration; the changes wrought upon inorganic and organic matter in the producon of soil fertility, ammonification, nitrification and dentrification; fixation of trogen symbiotically and non-symbiotically; methods of soil inoculation receive tention.

10 laboratory hours, credit, 5.
Assistant Professor Bradley.

erequisite, Microbiology 51.

81. **I.** Hygienic Microbiology. — For seniors; juniors may elect. An tempt is made to select certain material which is basic to public hygiene and nitation, as applied to man and animals. The microbiology of water supplies, od supplies, vaccines, antisera or antitoxins; the channels by which microganisms enter the body, the influence of body fluids and tissues upon them, dy reactions with micro-organisms (susceptibility and immunity); the microganisms of some of the most important infectious diseases, methods of control, cluding disinfectants and disinfection, antiseptics, antisepsis and asepsis, are eated.

10 laboratory hours, credit, 5.
Assistant Professor Bradley.

erequisite, Microbiology 51.

82. **I.** Dairy Microbiology. — For seniors; juniors may elect. Special emasis is placed upon milk supplies. The microbial content of milk, its source, its nificance, its control; microbial taints and changes in milk; groups or types of ganisms found in milk; milk as a carrier of disease-producing organisms; the lue of straining, aeration, clarification, centrifugal separation, temperature, steurization; the abnormal fermentations of milk; bacteriological milk standls and their interpretation; ripening of milk and cream; the bacterial content butter; a passing survey of the microbiology of cheeses; a study of special iry products, as ice cream, condensed milk, artificial milk drinks (the products microbial actions), represents a list of topics considered.

10 laboratory hours, credit, 5.
Professor Marshall and Miss Garvey.

erequisite, Microbiology 51.

33. **III.** Food Microbiology. — For seniors; juniors may elect. A study of e principles of food preservation, and food preservation by means of drying, nning, refrigerating and addition of chemicals, is pursued. Food fermentations, illustrated by bread, pickles, sauerkraut, ensilage, vinegar, wine, etc., are examid. Decomposition of foods, as may be seen in meat, oysters, fish, milk, etc., as ll as diseased and poisonous foods, receive consideration. Contamination of fd supplies by means of water, sewage, handling, exposure, diseased persons, ., is of especial significance, and is demonstrated by laboratory exercises. lboratory inspection of foods is now a subject of great import and is given aentiion.

10 laboratory hours, credit, 5.
Professor Marshall and Miss Garvey.

lerequisite, Microbiology 51.

Physics.

Professor Powers, Assistant Professor Alderman.

The fundamental and basic importance of the laws and phenomena of physics makes necessary no explanation of the introduction of this subject into the curriculum of an agricultural college. The logical development of the subject emphasizes the importance of physics as a science in itself. Special emphasis is laid, however, on the correlation of the principles studied with the sciences of agriculture, botany, chemistry and zoölogy, thus furnishing an extra tool by use of which the student's work in all the subjects may be more effective.

In Courses 25, 26 and 27 the subject-matter is presented with the idea of its special application primarily in the work in agriculture and general science. The full year's work is required of all students continuing work specifically in the Division of Science. Course 25 is required of all students. The subject-matter is especially selected and arranged for its practical application rather than its theoretical development. Courses 50, 51 and 52 are advised for students in chemistry, general biology, microbiology and general science. The subject-matter is selected, and the courses developed, with the idea of making the student proficient in laboratory manipulation. Sufficient theory is given in connection with the work to enable the student to apply the knowledge and practice thus gained in the departments indicated above.

The department has at its command a building on the east campus, containing a general lecture room and laboratory for sophomore work, a laboratory for junior work, and in the basement one small laboratory for quantitative work in light measurement. There is also in the basement a fairly well-equipped shop for the repair and construction of apparatus used in the department work. The usual apparatus for the demonstration in the lecture room is in the possession of the department.

Required Courses.

25. **I.** General Physics. — For sophomores. Mechanics of solids and fluids. This course includes statics, with equilibrium of rigid bodies, work, energy and friction; kinetics, considering rectilinear motion and motion in a curved path; harmonic motion; rotation of rigid bodies, including kinematics of rotation; liquids and gases, with properties of fluids at rest and in motion; properties of matter and its internal forces, including elasticity, capillarity, surface tension.
3 class hours. 1 2-hour laboratory period, credit 4.
Professors Powers and Alderman.

26. **II.** Electricity and Magnetism. — For sophomores; juniors and seniors may elect. Includes such subject-matter as magnetism, electrostatics, electric currents with their production, chemical, heating and mechanical effects; battery cells, measurement of voltage, current flow and resistance, motors and generators, oscillations.
3 class hours. 1 2-hour laboratory period, credit 4.
Professors Powers and Alderman.

27. **III.** Heat and Light. — For sophomores; juniors and seniors may elect. Thermometry, expansion, colorimetry and specific heat, transmission of heat, changes of state, radiation and absorption. Wave theory of light, optical instruments, analysis of light, color, interference, diffraction, polarization.
3 class hours. 1 2-hour laboratory period, credit 4.
Professors Powers and Alderman.

Elective Courses.

50. **I.** 51. **II.** 52. **III.** Experimental Physics. Heat, Light, Electricity, Magnetism and Thermionics. — For juniors; seniors may elect. This course consists of a series of physical measurements in the laboratory, accompanied by lectures. The lectures deal chiefly with the methods and principles involved

ı the laboratory work. High-grade instruments of precision are employed in ıe laboratory work, and the student is expected to acquire some ability to make ccurate observations. The primary object of the course is to develop in the ;udent scientific habits of thinking by direct personal observation of physical henomena.

class hour. 2 2-hour laboratory periods, credit, 3.

Professor POWERS.

rerequisite, Physics 27.

55. **III.** ANALYTICAL MECHANICS. — For juniors; seniors may elect. An ıtroduction to the application of the calculus to the mechanics of solids; statics ad kinetics of rigid bodies; elasticity; vector analysis. For students who have ıken or are taking Mathematics 52. Not given 1926–27.

class hours. Credit, 3.

Assistant Professor ALDERMAN.

75. **I.** 76. **II.** 77. **III.** THEORY OF LIGHT. — For seniors. Propagation of ght, formation of optical images, photography, optical instruments, interference, iffraction, spectroscopy, optical phenomena of the atmosphere, polarization and ouble refraction, magneto-optics, photo-electricity, radiation, electromagnetic aves, X-rays and crystal structure, electron theory, principle of relativity. Not iven 1926–27.

class hours. Credit, 3.

Professor POWERS.

rerequisite, Mathematics 51.

Veterinary Science and Animal Pathology.

Professor GAGE, Assistant Professor LENTZ.

The courses in veterinary science have been arranged to meet the needs (1) of ;udents who propose following practical agriculture; (2) of prospective students ; human and veterinary medicine; and (3) of teachers and laboratory workers in ıe biological sciences.

The department occupies a modern laboratory and hospital stable, built in ccordance with the latest principles of sanitation. Every precaution has been ıken in the arrangement of details to prevent the spread of disease, and to proide for effective heating, lighting, ventilation and disinfection.

The main building contains a large working laboratory for student use, and everal small private laboratories for special work. There is a lecture hall, a useum, a demonstration room, a photographing room and a workshop. The ospital stable contains a pharmacy, an operating hall, a post-mortem and dis:cting room, a poultry section, a section for cats and dogs, and 6 sections, sepaıted from each other, for horses, cattle, sheep and swine. The laboratory equipent consists of a dissectible Auzoux model of the horse and Auzoux models of ıe foot and the leg, showing the anatomy and the diseases of every part. The boratories also have modern, high-power microscopes, microtomes, incubators ıd sterilizers, for work in every department of veterinary science, including athology, serology and parasitology. There are skeletons of the horse, the cow, ıe sheep, the dog and the pig, and a growing collection of anatomical and pathogical specimens. The lecture room is provided with numerous maps, charts and agrams.

Elective Courses.

50. **II.** VETERINARY HYGIENE AND STABLE SANITATION. — For juniors; niors may elect. Familiarizes students with the relation of water, food, air, ght, ventilation, care of stables, disposal of excrement, individual hygiene, etc., the prevention of disease in farm animals.

class hours. Credit, 5.

Assistant Professor LENTZ.

53. **I.** Gross Veterinary Anatomy. — For juniors; seniors and gradue students may elect. The detailed study of the skeleton is followed by dissectn of the muscular system and the study of joints.

2 3-hour laboratory periods, credit 3.
The Department

54. **II.** Gross Veterinary Anatomy. — For juniors; seniors and gradue students may elect. The continuation of Veterinary 53, consisting of dissectn and study of the circulatory, nervous, digestive, respiratory, and genito-urin y systems.

2 3-hour laboratory periods, credit 3.
The Department

Prerequisite, Veterinary 53.

75. **I.** Comparative (Veterinary) Anatomy. — For seniors; juniors ny elect. The anatomy of the horse is studied in detail, and that of other farm a- mals, particularly the ox. This course is essential for those students wishing o elect Course 77. It is a lecture and demonstrational course and open to all stude s interested. It is not a course in dissection anatomy.

5 class hours. Credit 5.
Assistant Professor Lentz

76. **II.** General Veterinary Pathology. — For seniors; juniors may el . Fundamental, general, pathological conditions, as for example, inflammati , fever, hypertrophy, atrophy, etc., a knowledge of which is essential in preventi , diagnosis, and treatment of disease, are studied. The course in pathology is l- lowed by a brief consideration of materia medica, therapeutic measures, d poisonous plants.

5 class hours. Credit 5.
Assistant Professor Lentz

77. **III.** Applied General Pathology. — For seniors; juniors may el . This course is a continuation of Course 76. Particular attention is given to e etiology, the pathogenesis and the prophylaxis of the communicable and n- communicable diseases of the different species of domesticated animals. Lectu s and demonstrations.

5 class hours. Credit 5.
Assistant Professor Lentz

Prerequisites, Veterinary 75 or Veterinary 78, 79 and 80.

78. **I.** Essentials of General Pathology. — For seniors; juniors ny elect. Introduces students to some of the essential anatomical, histological d general physiological phenomena essential to the understanding of some of e simple general pathological conditions found in domestic animals. Some of e common methods of diagnosis are considered in the laboratory. The vari s chemical and biological reactions and tests are presented from the standpoint f pure science, showing applications of chemistry and biology. The course ser s to educate liberally and stimulate in the student of agriculture the appreciat n of some of the methods used in animal pathology for detecting and controll g some of the more common animal diseases. Lectures, demonstration and labo- tory work.

2 3-hour laboratory periods, credit 3.
Professor Gage

79. **II.** Essentials of General Animal Pathology. — For seniors; juni s may elect. A continuation of Course 78, devoted to a study of some of the co- mon pathological conditions by means of prepared sections, the aim being to dem-

rate to the student abnormal animal histological structures commonly observed hen material from various cases of animal diseases is prepared for microscopical udy. Some of the biological products used in protecting animals against disease e considered.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

rerequisite, Veterinary 78.

80. **III.** Essentials of General Animal Pathology. — For seniors; juniors ay elect. As stated in Courses 78 and 79.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

rerequisite, Veterinary 79.

85. **I.** Avian Pathology. — For seniors; juniors may elect. A course in oultry diseases. The object is to present information concerning the common seases of poultry, their etiology, diagnosis and prevention. Consists of a sys-matic study of the diseases of the alimentary tract, liver and abdominal region, llowed by a study of the diseases of the respiratory system, circulation and kid-eys. The important disease-producing external and internal parasites are con-dered; also diseases of the skin and reproductive organs. Lectures and demon-rations.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

86. **II.** Avian Pathology. — For seniors; juniors may elect. As stated ıder Course 85, also devoted to the study of some of the special diseases of poultry. ecent methods used in the control of these diseases are considered an opportunity fered the student for demonstrating various disease processes by means of pre-ıred slides. Lectures, demonstations and laboratory work.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

rerequisite, Veterinary 85.

87. **III.** Avian Pathology. — For seniors; juniors may elect. As stated ıder Courses 85 and 86.

2 3-hour laboratory periods, credit, 3.
Professor Gage.

rerequisite, Veterinary 86.

Zoology and Geology.

Professor Gordon, Mr. Gilbert.

The facts and principles of the sciences of zoölogy and geology have important oplications in industry and the arts, and with those of their sister sciences form body of knowledge of value and interest with which the educated man finds it ecessary to gain a close familiarity. The elective courses in this department and as offerings to students who wish to supplement their work in other depart-ents, or who, for any reason, wish to enlarge their knowledge in either zoölogy geology. Students are encouraged to consult the department about any courses hich may be available to them, and which might prove necessary or helpful for ıy line of work they may wish to follow.

The building occupied jointly by the department of entomology and the depart-ent of zoölogy and geology has for the work in zoölogy and geology laboratories uipped with gas, compound microscopes and the accessories needed for study these subjects. The Zoölogical Museum has a representative collection of sev-al thousand specimens of animals, and is drawn upon for material illustrating e various courses.

Zoölogy.

Required Course.

26. **I.** General Principles of Zoölogy. — For sophomores. An introdu tory course dealing with the basic features of animal structure, functions of organ relations of animals to each other and some of the important principles and do trines that have grown out of the study of animals.
2 class hours. 2 2-hour laboratory periods, credit,
The Department.

Elective Courses.

50. **I.** Synoptic Invertebrate Zoölogy; the Annelids and the Arthr pods. — For juniors; seniors may elect. A study of the classes and orders of tl annelid worms and the arthropods, exclusive of insects.
1 class hour. 2 2-hour laboratory periods, credit,
The Department.

Prerequisite, Zoölogy 26.

51. **II.** Synoptic Invertebrate Zoölogy; the Molluscs and the Echin derms. — For juniors; seniors may elect. A study of the classes and orders the molluscs and echinoderms.
1 class hour. 2 2-hour laboratory periods, credit,
The Department.

Prerequisite, Zoölogy 26.

52. **III.** Synoptic Invertebrate Zoölogy; Miscellaneous Invertebra Phyla. — For juniors; seniors may elect. A study of various selected phyla the non-vertebrated animals. For those who have not taken either or both of tl preceding courses in synoptic invertebrate zoölogy this course may include repr sentatives of the different phyla named therein.
1 class hour. 2 2-hour laboratory periods, credit,
The Department.

Prerequisite, Zoölogy 26.

53. **I.** Elements of Microscopic Technique. — For juniors; seniors ma elect. Gives the usual methods of preparing material for microscopic examin tion, including fixing, embedding, sectioning and differentiation by stains. Ma be supplemented by a study of selected normal tissues in connection with the physiological properties.
3 2-hour laboratory periods, credit,
The Department.

75. **I.** Special Zoölogy. — Juniors, seniors and graduates may apply f such special work as they are qualified to undertake.
1 class hour. 2 2-hour laboratory periods, credit,
The Department.

Prerequisite, Zoölogy 26.

76. **II.** Special Zoölogy. — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit,
The Department.

Prerequisite, Zoölogy 26.

77. **III.** Special Zoölogy. — Same as Course 75.
1 class hour. 2 2-hour laboratory periods, credit,
The Department.

Prerequisite, Zoölogy 26.

79. **III.** Ornithology. — For juniors; seniors may elect. The taxonomic characters, distribution and habits of birds.
1 class hour. 2 2-hour laboratory periods, credit, 3.
The Department.

Prerequisite, Zoölogy 26.

Geology.

52. **III.** General Geology. — For juniors; seniors may elect. A course in the various aspects of physical geology, dealing with materials of the earth's crust; their nature, origin and arrangement and the changes which they undergo.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Professor Gordon.

DIVISION OF THE HUMANITIES.

Professor Mackimmie.

Economics and Sociology.

Professor Mackimmie.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

The courses in economics and sociology are planned with the purpose of giving the student that knowledge and understanding of the important factors and problems in this field of study and life which every active citizen and educated man ought to have.

Required Course.

25. **I.** Introduction to Economic Principles and Problems. — For sophomores. For description of course see Course 50, **I.**
5 class hours. Credit, 5.
Professor Mackimmie.

Elective Courses.

26. **II.** Civilizations, Ancient and Modern. — For sophomores; juniors and seniors may elect. The evolutionary origin and history of man; characteristics of primitive man, departure from the animal status and beginnings of civilization; origin and development of industries, arts and sciences; the evolution of languages, warfare, migrations and social institutions; a study of the powerful natural and human forces that have brought man from the early stages to modern development; characteristic features of the leading civilizations and races of ancient and modern times; beneficial and dangerous factors in American life in view of the history of human civilization. Not given 1926–27.
5 class hours. Credit, 5.

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50. **I.** Introduction to Economic Principles and Problems. — For juniors and seniors. Definitions of economic terms, such as wealth, capital, value, etc.; factors of production, exchange and consumption; principles of economic production, supply and demand, diminishing returns, division of labor, productive organization, concentration of capital and labor, trust and monopoly problems, public control of production and distribution; principles of exchange, theories of value, money and its problems; international trade, tariff and free trade theories, American merchant marine, reciprocity, and trade treaties; forms of income, wages, interest, rent, profits and the forces which govern them; principles of spending, economy, luxury, conservation of individual and national resources; principles and agencies for saving, investments, banks, building associations, insurance of all kinds; schemes for social organization; socialism, communism, industrial democracy. Textbook and readings.
5 class hours. Credit, 5.
Professor Mackimmie.

51. **II.** Business and Industry. — For juniors and seniors. The form organization, administration and labor problems of business. Methods of orga izing, financing and administering corporations and partnerships; forms of bu ness administration, wholesaling, jobbing, retailing, advertising, credits and c lections; system of industrial remuneration for wage earners, co-operation a preserving industrial peace; problems concerned with protective legislation f workmen and employers, sweated industries, prison labor, child labor and industr education.
5 class hours. Credit,
Professor Mackimmie.

52. **III.** Public Finance, Taxation, Money and Banking. — For junio and seniors. Systems and problems of taxation as they are found in Europe a America; objects for spending public revenue; public debts and methods of orga izing them; systems of money and currency problems of America; types, metho and functions of banks; economic and financial crises and depressions in t United States; modern war finance. Readings and lectures.
5 class hours. Credit,
Professor Mackimmie.

75. **I.** Social Institutions and Social Reforms. — For seniors; juniors permission. Social institutions, such as the family, the State, property, religio and such current problems as eugenics, race suicide, divorce, crime and delinque classes, prison reform, prevention and treatment of dependents and defectiv poverty, its causes and preventions; constructive modern social reform mo ments for insurance of wage earners, protection of childhood, assurance of safe health and play time for all classes. The correctional and charitable institutio of Massachusetts are studied in considerable detail.
5 class hours. Credit,

History and Government.

Professor Mackimmie.

Required Courses.

25. II. American Government. — For sophomores. A study of the stru ture and operation of the machinery of our government; also a study of the h tory of its development from its inception to the present day.
3 class hours. Credit,

27. **III.** Citizenship. — For sophomores. A course designed to acquaint t student with the most important and immediate problems of government national, State and local — so that as a citizen he may make an intelligent co tribution towards their solution. Lectures and discussions.
2 class hours. Credit,

Elective Courses.

50. **I.** Government. — For juniors and seniors. Forms and working metho of the government of Great Britain, Germany, France, Russia, Switzerland, Ne Zealand and Canada; historic types and theories of government; forms a methods of Federal, State and local governments in America; progress and pro lems of democracy and new reform movements in organization and administratio new tendencies towards social legislation and extension of governmental contr
3 class hours. Credit,
Professor Mackimmie.

51. **II.** Modern European History. — For juniors and seniors. Th modern history of the principal countries of Europe, especially the great mov ments and revolutions that developed the nations up to the present generatio
3 class hours. Credit,
Professor Mackimmie.

52. **III.** European History Since 1870. — For juniors and seniors. The Franco-Prussian War and the formation of the German Empire, the unification of Italy, the Third French Republic, European Expansion in the East, the Russo-Japanese War, and the origin, events and results of the War of 1914. While a continuation of Course 51, this course will be complete in itself, and may be elected by those who have had no history training. Its aim is to provide the basis for an understanding of present-day conditions, and for an intelligent participation in world affairs.
3 class hours. Credit, 3.
Professor Mackimmie.

Languages and Literature.

Professor Patterson, Professor Ashley, Professor Julian, Assistant Professor Prince, Assistant Professor Rand, Mr. Nicholson, Mr. Halliday, Mr. Durkee.

English.

Required Courses.

1. **I.** 2. **II.** 3. **III.** English. — For freshmen. Composition. Intended to teach straight thinking, sound structure, clear and correct expression. Lectures, recitations, theme writing and conferences.
3 class hours. Credit, 3.
Professors Patterson, Prince, Rand and Mr. Nicholson.

25. **I.** 26. **II.** 27. **III.** English. — For sophomores. A general reading course in English literature.
2 class hours. Credit, 2.
Professor Patterson.

28. **I.** 29. **II.** 30. **III.** English. — For sophomores. English composition, oral and written.
1 class hour. Credit, 1.
Professors Patterson, Prince, Rand and Mr. Nicholson.

Elective Courses in English Language and Literature.

50. **I.** English Poetry of the Romantic Period (1927–28). — Alternates with Course 53. For juniors; seniors may elect. A course in history, appreciation and understanding. Some of the writers studied are Gray, Goldsmith, Burns, Scott, Wordsworth, Coleridge, Byron, Keats and Shelley.
3 class hours. Credit, 3.
Professor Patterson.

51. **II.** English Poetry in the Nineteenth Century (1926–27). — Alternates with Course 54. For juniors; seniors may elect. In general, this course is like Course 50. Tennyson, Browning, Mrs. Browning, Arnold, Clough, the Rossettis, Morris, Swinburne and others.
3 class hours. Credit, 3.
Professor Patterson.

57. **III.** English Poetry in the Nineteenth Century (1926–27). — Alternates with Course 58. For juniors; seniors may elect. As stated under Course 51.
3 class hours. Credit, 3.
Professor Patterson.

52. **III.** English Writers from Milton to Pope. — For juniors; seniors may elect. A survey course that emphasizes the leading writers, literary currents and the thought of the period. Some of the writers studied are Milton, Dryden, Addison, Swift and Pope.
3 class hours. Credit, 3.
Professor Patterson.

53. **I.** English Prose of the Romantic Period (1926–27). — For junior seniors may elect. A course in English prose paralleling Course 50. Some of th writers studied are Goldsmith, Coleridge, Lamb, DeQuincey and Hazlitt.
3 class hours. Credit,
Professor Patterson.

54. **II.** English Prose in the Nineteenth Century (1927–28). — F juniors; seniors may elect. Parallels Course 51. Among the writers considere will be Macaulay, Carlyle, Ruskin, Newman and Arnold.
3 class hours. Credit,
Professor Patterson.

58. **III.** English Prose in the Nineteenth Century (1927–28). — F juniors; seniors may elect. As stated under Course 54. Alternates with Course 5
3 class hours. Credit,
Professor Patterson.

55. **II.** American Literature. — For juniors; seniors may elect. A cour in the chief American prose writers; among those studied being Franklin, Broc den Brown, Irving, Cooper, Poe, Hawthorne, Emerson, Thoreau, Lowell, Holme Parkman.
3 class hours. Credit,
Assistant Professor Prince.

56. **III.** American Literature. — For juniors; seniors may elect. A cour in the chief American poets; among those studied being Freneau, Bryant, Po Emerson, Longfellow, Whittier, Holmes, Lowell, Whitman, Lanier.
3 class hours. Credit,
Assistant Professor Prince.

60. **I.** The Literature of Rural Life. — For juniors; seniors may elec A critical and appreciative study of writers, both in prose and poetry, who ha interpreted nature from the viewpoint of the lover of country life, and those wh have idealized agriculture, horticulture and other rural pursuits, together wit those who have upheld as an ideal the development of a rural environment i cities.
3 class hours. Credit,

61. **II.** The Literature of Rural Life. — For juniors; seniors may elec As stated under Course 60.
3 class hours. Credit,

Prerequisite, English 60.

65. **I.** Advanced Composition. — For juniors; seniors may elect. Advance work in expository writing, based upon specimens by contemporary authors an upon the personal experience of the student. Particular attention is given to orga ization, diction and style.
3 class hours. Credit,
Assistant Professor Rand.

66. **II.** Advanced Composition. — For juniors; seniors may elect. Th preparation of theses and similar manuscripts upon subjects selected by th student. The foundation of this course lies in an orderly accumulation of materia followed by an intelligent and readable interpretation of its significance.
3 class hours. Credit, 3
Assistant Professor Rand.

67. **III.** Advanced Composition. — For juniors; seniors may elect. Work journalistic and fictional narrative with supplementary reading.
class hours. Credit, 3.
Assistant Professor Rand.

75. **III.** Prose Fiction. — The short story or the novel. For seniors; juniors ay elect. Readings, reports and discussions. Not offered in 1926–27.
class hours or library equivalents. Credit, 3.

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79. **II.** Shakespeare. — For seniors; juniors may elect. A cursory survey the origin and rise of English drama is followed by the reading of about fifteen Shakespeare's plays, selected to indicate the evolution of the dramatist and to nphasize the various phases of his art. Every attempt is made to deepen the udent's appreciation of the personalities to be found in the plays, and of the eauty of the many memorable poetic passages.
class hours. Credit, 3.
Assistant Professor Rand.

80. **III.** Modern Drama. — For seniors; juniors may elect. This course aces the development of English drama from the time of the Restoration to the resent day. The purpose of the course is to impart an intelligent and sympathetic iterest in the theatre of the Twentieth Century.
class hours. Credit, 3.
Assistant Professor Rand.

Public Speaking.

Elective Courses.

50. **I.** Argumentation. — For juniors; seniors may elect. Presents the indamental principles of argumentation as applied to oral and written discourse, nd develops in the student power to handle argument convincingly and persuavely. Lectures, discussions of leading questions of the day, practice in briefrawing and the writing of forensics. The course is recommended for those who esire to enter the intercollegiate debates.
class hours. Credit, 3.
Assistant Professor Prince.

51. **III.** Occasional Oratory. — For juniors; seniors may elect. A study of he principles and the practice of formal oratory; the preparation and delivery of ne original oration; prescribed reading in oratory. The course is recommended or those who wish to enter the Flint Contest.
class hours. Credit, 3.
Assistant Professor Prince.

French, Spanish and Music.

Professor Ashley, Mr. Halliday.

The aim of the courses in French and Spanish is to give the student a practical nowledge of these languages for the purpose of wider reading and research, to itroduce him to some of their treasures in art and science, and through the literaure to acquaint him with the people. In the elementary courses as much time as ossible is given to oral work, to develop a speaking, as well as a reading, knowldge of the tongue.

French.

Required Courses.

1. **I.** 2. **II.** 3. **III.** Elementary French. — For freshmen; sophomores, iniors and seniors may elect. The essentials of grammar are rapidly taught nd will be accompanied by as much reading as possible. Required of freshmen

presenting German for entrance who do not continue that language and hav not studied French.
3 class hours. Credit, 3
Professor Ashley.

4. **I.** 5. **II.** 6. **III.** Intermediate French. — For freshmen; sophomores juniors and seniors may elect. Training for rapid reading. The reading of number of short stories, novels and plays; composition, reports on collateral reading from periodicals and scientific texts in the library.
3 class hours. Credit, 3
Mr. Halliday.
Prerequisite, required of freshmen who present two years of French for entranc and do not take German.

Elective Courses.

25. **I.** Intermediate French. — For sophomores; juniors and seniors ma elect. Training for rapid reading; the reading of a number of short stories, nove and plays; readings from periodicals and scientific texts in the library.
3 class hours. Credit, 3
Mr. Halliday.
Prerequisites, French 1, 2 and 3.

26. **II.** Intermediate French. — For sophomores; juniors and seniors ma elect. As stated under Course 25.
3 class hours. Credit, 3
Mr. Halliday.
Prerequisite, French 25.

27. **III.** Intermediate French. — For sophomores; juniors and seniors ma elect. As stated under Course 25.
3 class hours. Credit, 3
Mr. Halliday.
Prerequisite, French 26.

28. **I.** Advanced French. — For sophomores; juniors and seniors may elect A reading course. Balzac's "Eugénie Brandet" and "Le Père Goriot," and othe masterpieces of the nineteenth century; Brunetière's "Honoré de Balzac" an Harper's "Masters of French Literature," readings in the library and writte reports.
3 class hours. Credit, 3
Professor Ashley.
Prerequisites, French 4, 5 and 6.

29. **II.** Advanced French. — For sophomores; juniors and seniors may elect. As stated under Course 28.
3 class hours. Credit, 3
Professor Ashley.
Prerequisites, French 4, 5 and 6.

30. **III.** Advanced French. — For sophomores; juniors and seniors may elect. General view of the history of French literature; Kastner and Atkins "History of French Literature." Representative works of the important periods Outside reading.
3 class hours. Credit, 3
Professor Ashley.
Prerequisites, French 25 and 26, or French 28 and 29.

50. **I.** Scientific French. — For juniors; seniors may elect. Meets the requirements of individual students and equips them with exact English equivalents for the French scientific terms in their particular science. Word lists of scientific terms are required, and also weekly readings and reports from scientific works in the subject in which they are majoring. Several scientific works are read.

3 class hours. Credit, 3.

Mr. Halliday.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

51. **II.** Scientific French. — For juniors; seniors may elect. As stated under Course 50.

3 class hours. Credit, 3.

Mr. Halliday.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

52. **III.** Scientific French. — For juniors; seniors may elect. As stated under Course 50.

3 class hours. Credit, 3.

Mr. Halliday.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

75. **I.** French Literature. — For seniors; juniors may elect. The object of Courses 75, 76 and 77 is to give an introduction to recent movements in French literature. Course 75 deals with the drama, and plays by Augier, A. Dumas *fils*, Delavigne and other contemporary dramatists.

2 class hours. Credit, 2.

Professor Ashley.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

76. **II.** French Literature. — For seniors; juniors may elect. The novel. Works by Flaubert, the De Goncourts and Zola are read. Written reports are required on outside reading.

2 class hours. Credit, 2.

Professor Ashley.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

77. **III.** French Literature. — For seniors; juniors may elect. Modern criticism. Sainte-Beuve, "Causeries du Lundi" (Harper), and works by Taine and Renan. Reference book, Lanson's "Histoire de la Littérature Française."

2 class hours. Credit, 2.

Professor Ashley.

Prerequisites, French 4, 5 and 6, or French 25, 26 and 27.

Spanish.

Elective Courses.

50. **I.** Elementary Spanish. — For juniors; seniors may elect. Open to other students upon arrangement. Grammar, with special drill in pronunciation; exercises in conversation and composition. Reading from a reader and selected short stories.

3 class hours. Credit, 3.

Professor Ashley.

51. **II.** Elementary Spanish. — For juniors; seniors may elect. As stated in Course 50.

3 class hours. Credit, 3.

Professor Ashley.

Prerequisite, Spanish 50.

52. **III.** Elementary Spanish. — For juniors; seniors may elect. As state in Course 50.
3 class hours. Credit, 3
Professor Ashley.

Prerequisite, Spanish 51.

75. **I.** Modern Spanish Authors. — For seniors. Reading from moder Spanish novel and drama. Translation of English into Spanish. Private reading
2 class hours. Credit, 2
Professor Ashley.

Prerequisite, Spanish 52.

76. **II.** Modern Spanish Authors. — For seniors. As stated in Course 75
2 class hours. Credit, 2
Professor Ashley.

Prerequisite, Spanish 75.

77. **III.** Modern Spanish Authors. — For seniors. As stated in Course 75
2 class hours. Credit, 2
Professor Ashley.

Prerequisite, Spanish 76.

Music.

Elective Courses.

50. **I.** History and Interpretation of Music. — For juniors; seniors ma elect. History of music among the ancients; medieval and secular music; epoc of vocal counterpoint; development of monophony opera and oratorio; life an works of the greatest representatives of the classical school, — Bach, Hände Haydn, Gluck and Mozart.
1 class hour. Credit, 1
Professor Ashley.

51. **II.** History and Interpretation of Music. — For juniors; seniors ma elect. A continuation of Course 50. The Romantic school; Beethoven, Schubert Weber, Mendelssohn, Schumann, Chopin, Berlioz and Liszt; Wagner and th opera.
1 class hour. Credit, 1
Professor Ashley.

52. **III.** History and Interpretation of Music. — For juniors; senior may elect. The Modern school and Modern composers.
1 class hour. Credit, 1
Professor Ashley.

German.

Professor Julian, Mr. Durkee.

German.

The courses in German are intended to give the student a reading knowledge o the language and to introduce to him some of the masterpieces of German literature. To the student interested in pursuing advanced reading in scientific German opportunity is given to do corollary reading in his major subject, in collaboratio with the head of that department.

Required Courses.

1. **I.** 2. **II.** 3. **III.** Elementary German. — For freshmen; sophomores, juniors and seniors may elect. Grammar, composition and reading. Especial attention is given to oral work in German and to translation of English into German. Required of those presenting French for entrance who do not continue that language and have not studied German.
3 class hours. Credit, 3.
Mr. Durkee.

4. **I.** 5. **II.** 6. **III.** Intermediate German. — For freshmen; sophomores, juniors and seniors may elect. Selected works of Schiller, Heine and Goethe. Grammar review and advanced prose composition.
3 class hours. Credit, 3.
Mr. Durkee.

Prerequisite, required of freshmen who present two years of German for entrance and do not take French.

Elective Courses.

25. **I.** Intermediate German. — For sophomores; juniors and seniors may elect. Reading of such works as Sudermann's "Frau Sorge," "Wilhelm Tell," "Die Journalisten," etc. Grammar review.
3 class hours. Credit, 3.
Mr. Durkee.

Prerequisites, German 1, 2 and 3.

26. **II.** Intermediate German. — For sophomores; juniors and seniors may elect. As stated under Course 25.
3 class hours. Credit, 3.
Mr. Durkee.

Prerequisite, German 25.

27. **III.** Intermediate German. — For sophomores; juniors and seniors may elect. As stated under Course 25.
3 class hours. Credit, 3.
Mr. Durkee.

Prerequisite, German 26.

28. **I.** Advanced German. — For sophomores; juniors and seniors may elect. Reading and studying of Goethe's most important literary productions.
3 class hours. Credit, 3.
Professor Julian.

Prerequisites, German 4, 5 and 6.

29. **II.** Advanced German. — For sophomores; juniors and seniors may elect. Development of the German novel; rapid reading of great novelists.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 28.

30. **III.** Advanced German. — For sophomores; juniors and seniors may elect. As stated under Course 29.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 29.

50. **I.** Scientific German. — For juniors; seniors may elect. Reading in German of modern magazine articles and works of a scientific nature. Different work assigned according to needs of individual students.
3 class hours. Credit, 3.
Professor Julian.

Prerequisites, German 4, 5 and 6, or German 25, 26 and 27.

51. **II.** Scientific German. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 50.

52. **III.** Scientific German. — For juniors; seniors may elect. As stated under Course 50.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 51.

75. **I.** German Literature. — For seniors. Advanced language and literary study. Conducted entirely in German. Lectures on German literature and history; life, customs and travel in Germany. Collateral readings, including masterpieces of different epochs, such as "Niebelungenlied," Goethe's "Faust" and one modern typical drama. Not offered 1926–27.
3 class hours. Credit, 3.
Professor Julian.

Prerequisites, German 28, 29 and 30.

76. **II.** German Literature. — For seniors. As stated under Course 75.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 75.

77. **III.** German Literature. — For seniors. As stated under Course 75.
3 class hours. Credit, 3.
Professor Julian.

Prerequisite, German 76.

DIVISION OF RURAL SOCIAL SCIENCE.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Agricultural Economics.

Professor Cance, Assistant Professor Sawtelle, Miss Foley, Mr. Smart.

Instruction in agricultural economics is designed to show that the agricultural industry justified its existence chiefly as a supplier of food and raw textile materials for human consumption; that agricultural success is measured by production of values rather than by production of volume of agricultural products; that the goal of the farmer is the largest net profit over a long-time period; that agricultural production includes all processes from purchase of seed and fertilizer and preparation of seedbed until the product reaches the consumer, including collection, transportation, storage, financing, packing, handling and selling; that a knowledge of the business of agriculture and agricultural commerce is to-day more necessary than a knowledge of agricultural technique.

The work of this department is conducted by means of lectures, readings and research in both library and field. A catalogue, now containing some 12,000 cards, covering the various phases of agricultural economics, is maintained. The department is also supplied with a large collection of maps, charts and statistical reports on the prices and supply of agricultural products. A goodly number of regular reports of the Bureau of Markets and other divisions of the United States Department of Agriculture are available for the use of students. Two series of bound volumes of bulletins are kept in the department offices, with duplicate series in the college library; one series already contains 12 volumes on "Co-operation in Agriculture," and the other, 15 volumes on "Marketing of Farm Products."

Required Courses.

26. **II.** Agricultural Industry and Resources. — For sophomores. A descriptive course dealing with agriculture as an industry and its relation to physiography, movement of population, supply of labor, commercial development, transportation, public authority and consumers' demand. The principal agricultural resources of the United States are studied with reference to commer-

cial importance, geographical distribution, present condition and means of increasing the value of the product and cheapening cost of production. Lectures, assigned readings, class topics and discussions.
4 class hours. 1 2-hour laboratory period, credit, 5.
Miss Foley.

Elective Courses.

50. **I.** Elements of Agricultural Economics. — For juniors; seniors may elect. This course is designed to accompany or follow the course in elements of economics. It deals with the economic principles underlying the welfare and prosperity of the farmer and those institutions upon which his economic success depends; the economic elements in the production and distribution of agricultural wealth; means of exchange; problems of land tenure and land values; taxation of farm property; and the maintenance of the economics status of the farmer. Lectures, text, readings, topics and field work.
5 class hours. Credit, 5.
Professor Cance.

51. **III.** The Evolution of Agriculture. — For juniors; seniors may elect. A general survey of the evolution of the agricultural industry. Significant developments are traced and their causes and consequences studied. An attempt is made to give the student a knowledge of the changes which have taken place and which are taking place in the agricultural industry, the conditions which accompany these changes, and to furnish a basis by which the significance and the course of present and future developments in agriculture may be judged. Special emphasis will be placed on the development of agriculture in New England and the United States. Lectures, readings and library work.
5 class hours. Credit, 5.
Assistant Professor Sawtelle.

52. **II.** Co-operation in Agriculture. — For juniors; seniors may elect. The history, principles and business relations of agricultural co-operation. (1) A survey of the development, methods and economic results of farmers' organizations and great co-operative movements; (2) the business organization of agriculture abroad, and the present aspects and tendencies in the United States; (3) the principles underlying successful co-operative endeavor among farmers, practical working plans for co-operative associations, with particular reference to purchase of supplies and the marketing of perishable products. Lectures, text, assigned readings and practical exercises.
5 class hours. Credit, 5.
Professor Cance.

53. **III.** The Agricultural Market. — For juniors; seniors and graduate students may elect. A study of the forces and conditions which determine the prices of farm products and the mechanism, methods and problems concerned with transporting, storing and distributing them. Supply and demand, course of prices, terminal facilities, the middleman system, speculation in agricultural products, protective legislation, the retail market and direct sales are taken up. The characteristics and possibilities of the New England market are given special attention. Lectures, readings, assigned studies and field work.
5 class hours. Credit, 5.
Professor Cance.

54. **III.** Economics of Consumption. — For juniors and seniors; graduate students may elect. The purpose of this course is a consideration of the importance of consumption in modern industry and commerce; a classification of consumption wants; a survey of the sources of consumption goods, particularly food. This will be followed by a study of standards of living, the laws of consumption, and a discussion on the administration of income. Finally, a short study will be made of the relation of consumption to the problems of population and to the develop-

ment of the rural people. Lectures, assigned readings, and practical exercise
Offered for the year 1926–27.
3 class hours. Credit,
Professor CANCE and Miss FOLEY.

75. **II.** RURAL AND BUSINESS LAW. — For seniors; juniors may elect. Lan titles, public roads, rights incident to ownership of livestock, contracts, comme cial paper and distinctions between personal and real property. Text, writte exercises, lectures and class discussions.
5 class hours. Credit,
Mr. SMART.

76. **II.** TRANSPORTATION OF AGRICULTURAL PRODUCTS. — For seniors an graduate students; juniors may elect. The development of highway, waterwa and railway transportation and its relation to the agricultural development the country; the principles governing the operation and control of transportatio agencies; present-day problems relating to the shipment of farm products, rate facilities and services; methods of reducing wastes in transportation; the eco nomics of the good roads movement and of motor transportation. Lectures, te and field work.
5 class hours. Credit,
Professor CANCE.

77. **I.** PROBLEMS IN AGRICULTURAL ECONOMICS. — For seniors and graduat students; juniors may elect. An advanced course for those desirous of studyin more intensively some of the economic problems affecting the farmer and th production and distribution of the food supply. Current economic questions agricultural legislation, government aids and subsidies, and causes affecting lan valuations are some of the problems discussed. Particular attention will be give to economic problems relating to New England and to agricultural commerce Students will be encouraged to pursue lines of individual interest.
5 class hours. Credit, 5
Professor CANCE.

78. **III.** AGRICULTURAL CREDIT FACILITIES. — For seniors and juniors. Lec tures, discussions and assigned readings on credit needs of farmers; the legitimat use of credit in the acquisition of land, and the production, storage and marketin of agricultural products; the development of national and State rural credit insti tutions and laws; the powers and methods of operation of credit institutions wit reference to the supply of credit for agricultural purposes; the methods by whic the individual may increase his credit standing and borrowing power; ways in which the present credit facilities may be increased.
3 class hours. Credit, 3.
Assistant Professor SAWTELLE.

79. **I.** AGRICULTURAL STATISTICS. — For seniors; juniors and graduate students may elect. The nature and sources of agricultural statistics, the methods of obtaining numerical facts, of analyzing and drawing conclusions from statistical data, and the methods of presenting in a true and forceful manner the statistical facts of the agricultural industry. Opportunity is given in the laboratory for practice in the use of statistical methods and processes, and to acquire experience in dealing with practical statistical problems. The application of statistics and statistical methods in the fields of agricultural economics, extension work, education, journalism and the business matters connected with farm operation is emphasized.
2 class hours. 3 2-hour laboratory periods, credit, 5.
Assistant Professor SAWTELLE.

80. **I.** SEMINAR. — For seniors and graduate students. Research in agricultural economics and history; problems of New England agriculture. Library work and reports. If desirable some other topic may be substituted.
1 or 2 2-hour conference periods, credit, 1 or 2.
The DEPARTMENT.

81. **II.** . Seminar. — For seniors and graduate students. As stated in Course 0.

1 or 2 2-hour conference periods, credit, 1 or 2.
The Department.

82. **III.** Seminar. — For seniors and graduate students. As stated in ourse 80.

1 or 2 2-hour conference periods, credit, 1 or 2.
The Department.

83. **I.** Salesmanship of Agricultural Products. — For seniors; juniors ıay elect. The course embraces a study of the principles and practices that are ıvolved in the selling of goods and services. The application of these principles f salesmanship to the disposal of agricultural products is especially emphasized. 'ypes of sales, motives for buying, securing interviews, types of prospects, preparaion of sales talks, meeting objections and excuses, and sales demonstrations by tudents and the instructor are included.

class hours. Credit, 2.
Miss Foley.

84. **III.** Advertising Agricultural Products. — For seniors; juniors may lect. A course dealing with the application of the principles of advertising to gricultural products. A study of the nature of advertising, the economics of dvertising, the use of media, copy, psychology as applied to advertising, layout, he advertising campaign, advertising agency, etc., is made. The solution of ractical problems to emphasize different phases of advertising is required by tudents.

class hours. Credit, 2.
Miss Foley.

85. **II.** Agricultural Prices. — For seniors and graduate students. A tudy of the prices of agricultural products and other commodities which are of nportance in the agricultural industry. Limited to five students.

2 or 3 2-hour laboratory periods, credit, 2 or 3.
Assistant Professor Sawtelle.

86. **III.** Agricultural Prices. — For seniors and graduate students as tated in Course 85. Limited to five students.

2 or 3 2-hour laboratory periods, credit, 2 or 3.
Assistant Professor Sawtelle.

87. **III.** Foreign Trade in Agricultural Products. — For seniors and raduates; juniors may elect. A general course embracing a study of the prin-iples and practices of international trade and the foreign commerce of the United tates, particularly with reference to agricultural products. The development nd present status of foreign trade in agricultural products, trade relations with oreign nations, the agencies and practices of foreign trade, foreign trade salesmanhip and advertising, the status of New England with reference to foreign trade re some of the topics which will be presented. The work in the course will also nclude a personal study of special features of foreign trade and of the trade imortance of specific subjects. Textbook, class discussions and class topics.

class hours. Credit, 3.
Miss Foley.

88. **III.** Business Accounting. — For seniors; juniors may elect. This ourse aims to give the student an elementary working knowledge of the principles nderlying the accounting system in the gathering, analysis and interpretation of ccounting data, and of the methods used in accounting and preparing the usual ypes of business statements. The managerial uses of accounting as a means of usiness control is the keynote of the course.

class hour. 2 2-hour laboratory periods, credit, 3.
Admission by permission of the instructor only.

Agricultural Education.

Professor Welles, Professor Glick, Mr. Heald.[1]

The primary aim of the department is to train students for service in some for of educational work. Students desiring state approval as teachers of agricultu or related subjects should confer with the head of the department as early as po sible to insure a desirable range of preparation, including farm experience, a pa of which may be gained after entering college. They should also become a quainted with the State Agent for Agricultural Teacher-Training who approv candidates for positions in special schools and departments of agriculture in hi schools. A Teacher-Training certificate will be awarded by the Vocational Ed cational Division to students who qualify as to farm experience, technical subject and educational courses as advised.

The department seeks to be of the greatest possible service to students who a prepared to teach and whose scholastic standing and qualifications generally see to make them suitable candidates for positions. Students who major in oth departments but expect to teach should consult this department regarding t educational courses best suited to their purposes.

The department recommends to the State Department of Education su graduates of the college as are entitled to receive the high school teachers' te certificate.

29. **II.** Problems in Education. — For sophomores in the Division Rural Social Science. The aim of this course is to introduce the student to t field of education through the study of the educational problems in the history America from the beginning of the Colonial period to the present time. Such a understanding is desired in order that the citizens of tomorrow may be able solve their own educational problems.
3 class hours. Credit,
Professor Welles.

51. **I** and **II.** Principles and Methods of Teaching. — For juniors; senio may elect. This course is intended for students who expect to become teacher Others must consult the head of the department before registering. Consists of study of the general principles of teaching and school management applied t particular "cases" taken from actual experience in public school work. Discussio of the rational solutions of these "cases" tend to fix the ideas in methods. Certai assigned and optional readings are required. These are both technical and inspira tional in character and cover the best there is printed on the subject of methods teaching. They are supported by sharp class discussions of the main issues. Ob servation visits to schools in session are required with full reports. Exercises i teaching under supervision are also required with criticism and discussion o methods and results. A good text is used as the basis of the course.
5 class hours. Credit, 5
Professor Welles.

52. **I.** History and Philosophy of Education. — For seniors and graduat students; juniors may elect. A general course in the history of educational theor and practice. Special emphasis is placed upon the philosophical background o education.
5 class hours. Credit, 5
Professor Glick.

55. **I** and **II.** General Psychology. — For juniors; seniors and graduat students may elect. This is an introductory course for those anticipating furthe study in psychology as well as a practical and cultural course for those who ca take only one course in this field. It deals wtith the fundamental principles o psychology and their application to the understanding and control of huma thought and action.
5 class hours. Credit, 5
Professor Glick.

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[1] State Agent for Agricultural Teacher-Training representing the State Department of Education in the administration of vocational education acts.

56. **II** and **III**. Educational Psychology. — For juniors; seniors and grad-ate students may elect. It is a direct application of psychology to the field of lucation and is a basic course for both general and specific methods. The course eals with the original nature of the child, the psychology of learning, individual ifferences, transfer of training, mental tests, etc. Intended primarily for pro-ective teachers, but open to others who are sufficiently interested.
class hours. Credit, 5.
Professor Glick.

rerequisite, Agricultural Education 55 or consent of the instructor.

75. **II.** Principles of Secondary Education. — For seniors; juniors may ect. This is a study of the American high school. It is designed to acquaint the udent with the aims of high school education, the characteristics and tendencies f high school students, the high school curriculum, extra-curricular activities and ie best ideas in regard to the administration of high schools.
class hours. Credit, 3.
Professor Welles.

76. **I** and **III**. Special Methods in Teaching Agriculture and Related cience. — For seniors; juniors and others qualified may elect. Owing to the ecialized nature of this course, the head of the department must be consulted efore registration. The course aims to set out clearly the main details in teaching griculture and related science from a vocational point of view. The home project considered the basis. The work covers material and method, laws, policies, ate requirements, common practices, teachers' subject and method outlines, roject outlines, lesson plans, moot class teaching, observation, references, weekly ral and written reports, etc. The principle of job analysis is employed throughout ie course.
class hours. Credit, 5.
Professor Welles.

77. **III.** Methods in Extension Teaching. — For seniors; juniors and hers qualified may elect. Candidates must consult the head of the department efore registering. The course deals with various phases of extension work and ie methods by which this work is accomplished. The specific lines are those of ie county agent, boys' and girls' club leader, county demonstration agent and gricultural specialist. The different phases of the work will be discussed by embers of the Extension staff who are specialists in their particular lines. The ourse will be offered jointly by the Extension Service and the department of gricultural Education.
class hours. Credit, 3.
Professor Welles and Extension Service Staff.

79. **III.** Tests and Measurements. — Limited to fifteen seniors majoring the department. A study of the development, theory and construction of the arious types of tests and measurements with special emphasis upon their use in ie schools. Practice is given in the administration and scoring of tests. Modern atistical methods are applied to the interpretation of the results.
class hours. 2 laboratory hours, credit, 3.
Professor Glick.

80. **I, II** and **III**. Supervised Teaching. — (Includes: (*a*) apprentice,) practice and (*c*) observation teaching.) Primarily for seniors; juniors and hers qualified may be admitted by arrangement. Under certain conditions a udent may absent himself from college during one term of his junior or senior ear for apprentice teaching in agriculture. For detailed information, consult the ead of the department.

Opportunities for practice teaching in all other lines of work are sought on the ampus and in nearby high schools. A limited amount of study of teaching by oservation is permissible. Each student is required to pursue a course of professional reading bearing upon the subject he is teaching or observing. The amount of credit depends upon the number, character and length of teaching or observation exercises and conferences. Scheduled by arrangement.

Credit, 1 to 5.
The DEPARTMENT.

81. **III.** SEMINAR IN METHODS OF TEACHING. — Open to seniors majoring in Agricultural Education; graduate students and others by arrangement. This is an opportunity for those definitely intending to teach to make further studies in special lines other than agriculture, which is provided for in Agricultural Education 76. These include methods in college teaching, special methods in science, etc.

1 2-hour conference period, credit 2.
Professor WELLES.

Prerequisites, Agricultural Education 51 and 56 or equivalents.

83. **III.** SEMINAR IN APPLIED PSYCHOLOGY. — For seniors and graduate students. Intended for those who desire to study the application of psychology in special fields such as salesmanship, advertising, medicine, law, public office, extension work, education, business, etc.

1 2-hour conference period, credit 2.
Professor GLICK.

Prerequisites, Agricultural Education 55 and 56 or 85.

85. **I.** VOCATIONAL PSYCHOLOGY. — For seniors and graduate students. An application of psychology to the various fields of thought and action other than education.

3 class hours. Credit 3.
Professor GLICK.

Prerequisite, Agricultural Education 55 or consent of the instructor.

95. **II.** MODERN PHILOSOPHY OF EDUCATION. — For seniors and graduate students; juniors may elect. A general survey of modern philosophical theories and tendencies with special emphasis upon their influence in determining present educational objectives and procedures. An analysis of the theories underlying various national cultures and ideals and the significance of education in realizing definite educational objectives. Emphasis is placed upon the significance of curriculums in realizing definite educational objectives.

3 class hours. Credit 3.
Professor GLICK.

Prerequisite, Agricultural Education 52 or consent of instructor.

Rural Sociology.

Assistant Professor CUTLER.

The courses in rural sociology are designed for two purposes: first, to give students an appreciation of the general problems of country life; second, to afford a definite training for students who wish to take up some specific form of social service. In the last ten years rural sociology has been introduced as a subject into more than 50 per cent of the agricultural schools and colleges. There is a good demand for teachers, and an increasing opportunity in other directions in this subject. The courses afford the student an opportunity to pursue graduate as well as undergraduate work. The library of the college is unusually well equipped with rural sociological material.

Required Course.

27. **III.** ELEMENTS OF RURAL SOCIOLOGY. — For sophomores. A broad survey of the field of rural sociology, including such topics as the origin of rural sociology, its methods and problems; relation of sociological to the scientific and technical

pects of agricultural problems; the development of the rural community in ew England and the west, religious, educational and social ideals of rural people; aracteristics and influence of the rural environment, the movement of the rural pulation, the effects of immigration; rural institutions, the school, the church, cal government, effects of modern conditions of life on rural institutions; rural ganization; problems of progress, an analysis of the needs of rural life in its rther development. Lectures, readings and essays on assigned topics.
class hours. Credit, 3.
Assistant Professor CUTLER.

Elective Courses.

50. **I.** RURAL VILLAGE AND TOWN SOCIOLOGY. — For juniors; seniors may ect. Village history and evolution; present status and importance of the small wn; its relation to farm and city; institutional, economic, social, cultural and oral aspects; the problems of citizenship, organization and leadership presented the small town; schemes for improvement criticized and evaluated. This urse has special value for New Englanders who wish to understand their semi-ban and town communities. Lectures, discussions and topical reports.
class hours. Credit, 3.
Assistant Professor CUTLER.

51. **II.** RURAL GOVERNMENT. — For juniors; seniors may elect. A general rvey of the development of rural government in the United States, origin of the ew England town, its influence upon the west, county government, the influence the farmer in legislation, good roads movement, credit facilities, taxation, ards of agriculture, agricultural colleges and experiment stations in relation to ral welfare; national government; a general survey of political organizations d movements among farmers in the United States and foreign countries and their fluence in shaping legislation; relation of the Department of Agriculture, postal stem, the various national commissions and agencies to rural welfare. Lectures, adings, written exercises on assigned topics.
class hours. Credit, 3.
Assistant Professor CUTLER.

52. **III.** RURAL ORGANIZATION. — For juniors; seniors may elect. A study of e organized agencies by which rural communities carry on their various forms of sociated life, particularly a study of the ways by which the domestic, economic, ltural, religious and political institutions contribute to rural betterment; prin-les underlying leadership, qualifications of the paid leader and the lay leader; e field of rural social service, national, State and local, preparation and oppor-nity for service; rural community building, a study of organized ways and means which aid is given local communities. The method, scope and history of local, ate and national associations formed about some farm product, their influence forming class consciousness and in shaping agrarian legislation; need of federa-n. Lectures, readings and essays on assigned topics.
class hours. Credit, 3.
Assistant Professor CUTLER.

76. **I.** FIELD WORK IN RURAL SOCIOLOGY. — For seniors; juniors may elect. esigned to meet the needs of students who wish to do some constructive work rural social service while still in college. The work is carried on in co-operation th the various college agencies engaged in rural service. Any project for which edit in this course is to be asked must first have the approval of the head of the partment.
2 to 6 laboratory hours, credits, 1 to 3.
Assistant Professor CUTLER.
erequisites, Rural Sociology 27 and preferably 50 or 52.

77. **II.** RURAL SOCIAL RESEARCH AND SURVEYS. — For seniors; juniors may ct. A careful study is made of the scientific method as applied to social prob-ns, the technique of investigation and research; the procedure of gathering

sociological data by means of the survey; the interpretation and graphic pres-tation of statistical facts. This course is indispensable for those contemplat any kind of social work. Text, lectures and laboratory work.

3 class hours. Credit,

Assistant Professor Cutler.

79. **I.** Seminar. — Enrollment is open to seniors, students majoring in ru sociology and others especially prepared.

1 to 3 class hours. Credit, 1 to

Assistant Professor Cutler.

80. **II.** Seminar. — Enrollment is open to seniors, students majoring in ru sociology and others especially prepared.

1 to 3 class hours. Credit, 1 to

Assistant Professor Cutler.

81. **III.** Seminar. — Enrollment is open to seniors, students majoring rural sociology and others especially prepared.

1 to 3 class hours. Credit, 1 to

Assistant Professor Cutler.

Rural Home Life.

Professor Skinner, Assistant Professor Knowlton, Assistant Professor Tucker.

The emphasis of the work in Home Economics is upon home making as a fun-mental vocation. To this end, not only technical courses are offered, but also th which will tend to give the student a better understanding of the place which home should take as a factor in community life, and a sympathetic attitude tow the problems of everyday life.

The work is largely prescribed in the first two years and gives the necess basis for the development of courses in Home Economics during the junior a senior years. It is possible for graduates of this course, if they have skillfu chosen their electives in the field of agriculture or horticulture, to engage in ho industries for profit and to engage in certain phases of professional work in the fi of Home Economics.

The food laboratory located in Fernald Hall is fitted with individual cabin and gas stoves. Provision is made for practice in the preparation and serving meals with the family as a unit. The clothing laboratory located in Stockbrid Hall is provided with modern equipment. The related science is given in t laboratories of the various departments of the college.

1. **I.** Introduction to Home Economics. — For freshmen. Lectures the history and evolution of the home; social customs and their value in fam relationships; healthful and suitable care of the wardrobe; principles of nutriti as applied to the student's life; the student's budget, and the keeping of perso accounts.

2 class hours. Credit,

Miss Skinner.

28. **I.** 29. **II.** Clothing and Textiles. — For sophomores. A study of t selection and purchase of suitable materials, their character and cost; appropria ness and simplicity in dress. Practical laboratory work includes designing a drafting of patterns, the use of commercial patterns, and the making and repa ing of garments.

1 class hour. 3 2-hour laboratory periods, credit,

Miss Tucker.

32. **III.** Applied Design. — For sophomores. The application of the pri ciples of design to specific problems of everyday life, using various media for th execution.

3 2-hour laboratory periods, credit,

Miss Tucker.

0. **I.** Foods. — For juniors. A study of foods in their scientific and economic ects, with the preparation of simple breakfasts and luncheons.
ass hours. 3 2-hour laboratory periods, credit, 5.
Miss Knowlton.

1. **II.** Foods. — For juniors. A further study of foods on the basis of meal nning in the home, with especial emphasis on dinners and the day's meals as a ›le.
ass hours. 2 3-hour laboratory periods, credit, 5.
Miss Knowlton.

2. **III.** Dietetics. — For juniors. A study of the food requirement through- infancy, childhood, adolescence, adult life and old age, considering the energy ue of foods and the nutritive properties of foodstuffs. Typical dietaries are nned for each period, with special regard to economic and social conditions.
lass hours. 2 3-hour laboratory periods, credit, 5.
Miss Knowlton.

6. **I.** Clothing. — For juniors. This course aims to develop initiative, inde- ıdence and art in designing garments for figures of different types, with special phasis on proportion, color and texture. Laboratory work will be concerned h more difficult problems of garment construction.
lass hours. 3 2-hour laboratory periods, credit, 5.
Miss Tucker.

1. **III.** House Furnishing. — For juniors. A study of the fundamental nciples of furnishing a moderate-sized home from an æsthetic and an economic ndpoint.
lass hours. 1 2-hour laboratory period, credit, 3.
Miss Tucker.

'6. **I.** Home Management. — For seniors. The application of the principles scientific management to the household, and the elements of successful home king. The family income, cost of living, household accounts, the budget and apportionment. The responsibility of the woman to her family and the com- nity in establishing right standards of living.
lass hours. Credit, 4.
Miss Skinner.

'8. **II.** Home Nursing. — For seniors. A study of the care of the family ılth; simple diseases and their prevention; the care of young children and in- ids; first aid to the injured.
lass hours. Credit, 3.
Miss Skinner.

1. **I.** The Community of the Home Economics Graduate. — For seniors. is course is intended to be a practical application of Home Economics to the ious social, economic, industrial and educational problems relating to the home ich the Home Economics graduate may meet in any community, either as an ployed worker or as a volunteer. This may include a field trip to Boston and er centers at an estimated cost of ten dollars. Recommended only to those suing a major in Home Economics.
lass hours. 1 2-hour laboratory period, credit, 3.
Miss Knowlton.

2. **II.** Health Education. — For seniors. This course is intended to show v the Home Economics graduate fits into the health program of the school, ıer as a teacher or as volunteer worker. Recommended only to those pursuing ıajor in Home Economics.
lass hours. 1 2-hour laboratory period, credit, 3.
Miss Knowlton.

83. **III.** Field Problems under Supervision. — For seniors. This course is intended to be a more intensive application of Home Economics to special community problems and to serve as a beginning of simple research work. Recommended only to those pursuing a major in Home Economics.
2 class hours. 1 2-hour laboratory period, credit 3.
The Department.

84. **III.** Millinery. — For seniors. This course considers different types of hats, their appropriateness and becomingness, with practical work in designing frames, remodeling commercial frames, covering, trimming and renovating hats. Not given 1926–27. 3 2-hour laboratory periods, credit 3.

GENERAL DEPARTMENTS.

[Heavy-faced type indicates the term in which the course is given. Numbering of courses: 1 to 24, inclusive, freshmen; 25 to 49, inclusive, sophomores; 50 to 74, inclusive, juniors; 75 to 99, inclusive, seniors.]

Military Science and Tactics.

Major N. Butler Briscoe, Cav. (D. O. L.), U. S. A.; Captain Dwight Hughes, Jr., Cav. (D. O. L.), U. S. A.; Captain Edwin M. Sumner, Cav. (D. O. L.), U. S. A.; Technical Sergeant John J. Lee, U. S. A., Retired; Technical Sergeant James A. Warren, Cav. (D. E. M. L.), U. S. A.; and a detachment of enlisted men of the United States Army.

Under act of Congress (July 2, 1862) military instruction under a regular army officer was required in this college of all able-bodied male students. Under act of Congress June 3, 1916, as amended by act of Congress Sept. 8, 1916, there was established at this college in April, 1917, an infantry unit of the Reserve Officers' Training Corps. Following the World War and an act of Congress (July 9, 1918) the Reserve Officers' Training Corps is in operation under the regulation of the War Department, administered by the president of the college and the professor of military science and tactics.

Beginning with the fall term, 1920–21, the infantry unit of the Reserve Officers' Training Corps was converted into a cavalry unit.

The primary object of the Reserve Officers' Training Corps is to provide systematic military training at civil educational institutions, for the ultimate purpose of qualifying selected students of such institutions as reserve officers in the military forces of the United States. It is intended to attain this object during the time the students are pursuing their general or professional studies, with the least practicable interference with their civil careers, by employing methods designed to fit men physically, mentally and morally for pursuits of peace as well as war.

All male candidates for a degree in a four-year course must take for two years at least three hours a week of military training.

Students in their junior and senior years, who are approved by the president and the professor of military science and tactics, may take the advanced course if they so elect. The advanced course consists of at least five hours per week and a summer camp of about six weeks during the summer vacation, between the junior and senior years. Students taking this course are paid by the Federal government at a rate to be fixed by the Secretary of War, not to exceed the value of the army ration. The rate now fixed is 30 cents per day, which amounts to about $103 per year. Students graduating in the advanced course are eligible for commissions in the Officers' Reserve Corps, *but are not required to accept such commissions if offered.*

The uniform furnished to Freshmen and Sophomore (Basic Class) is of Olive Drab Woolen cloth, and is supplied by the Federal Government without cost. The uniforms for the Junior and Senior (Advanced Class) are of Forest Green Woolen cloth fitted and especially made for the individual student. It is expected that eventually this uniform will be furnished for the Basic Class also. This uniform is also furnished without cost to the student.

The course for cavalry units of the Reserve Officers' Training Corps includes theoretical and practical instruction in all phases of cavalry work, so distributed over the four-year college course as to qualify students at the end of the fresın year as privates of cavalry; at the end of the sophomore year as non-com-ssioned officers of cavalry; and upon graduation as reserve officers. The in-·uction in this department covers cavalry drill, cavalry weapons, — *i.e.*, rifle, stol, saber, automatic rifle and machine gun, — map reading and military etching, minor tactics, equitation, etc. The course in equitation includes cross-untry riding and instruction in polo. So far as season and weather permit, struction is of a practical nature out of doors.

Required Courses.

1. **I.** 2. **II.** 3. **III.** For freshmen. Theoretical and practical instruction courtesy and discipline, riding and drills, rifle marksmanship, cavalry equip-ent and arms, physical training, history, dismounted sports.

3 scheduled hours, credit, 2.
Professor BRISCOE and ASSISTANTS.

25. **I.** 26. **II.** 27. **III.** For sophomores. Theoretical and practical struction in leadership, map reading and map making, hygiene, sanitation, and st aid, cavalry equipment and arms, pistol marksmanship, riding and drill, ounted sports.

3 scheduled hours, credit, 2.
Professor BRISCOE and ASSISTANTS.

50. **I.** 51. **II.** 52. **III.** For juniors. Cavalry drill and riding, leadership d command, engineering (bridges, explosives), cavalry equipment and arms, ection and care of horses and mules, communications (telephone, telegraph, dio), mounted sports, jumping, polo.

5 scheduled hours, credit, 4.
Professor BRISCOE and ASSISTANTS.

75. **I.** 76. **II.** 77. **III.** For seniors. Transportation (wagon and pack), rrespondence and records, law, leadership and command, drill and riding, history, ounted sports, competitions, horse show preparation and management, polo, oss-country riding.

5 scheduled hours, credit, 4.
Professor BRISCOE and ASSISTANTS.

Physical Education and Hygiene.

Professor HICKS, Professor GORE, Mrs. HICKS, Mr. BALL, Mr. DERBY, Mr. COUHIG.

The purpose of the courses offered by this department is to provide active exer-e and to instruct every student how to care for his health and maintain his ysical condition while carrying on his college course.

The equipment consists of the Alumni Athletic Field, which has room for two otball fields, a quarter-mile cinder track with a 220 straightaway, and the base-ll diamond; and also the old field for class football and baseball, two tennis urts, and the drill hall floor for basket ball. For several years the drill hall or was used for class work in gymnastics, but its condition has become so bad at this has been discontinued. During the winter months a hockey rink is pro-led on the college pond.

[All undergraduate male students are given a physical examination upon entering.]

MEN.

Required Courses.

1. **I.** HYGIENE. — For freshmen. Lectures on personal hygiene.
class hour. Credit, 1.
Professor HICKS.

2. **I.** RECREATION. — For freshmen. Outdoor games.
2 laboratory hours, credit, 1.
The DEPARTMENT.

3. **III.** Recreation. — For freshmen. Outdoor games.
2 laboratory hours, credit,
The Department.

7. **I.** 8. **II.** 9. **III.** Recreation. — Military substitute for freshman me
3 scheduled hours, credit,
The Department.

25. **I.** Recreation. — For sophomores. Outdoor games.
2 laboratory hours, credit,
The Department.

26. **III.** Recreation. — For sophomores. Outdoor games.
2 laboratory hours, credit,
The Department.

30. **I.** 31. **II.** 32. **III.** Recreation. — Military substitute for sophomo men.
3 scheduled hours, credit,
The Department.

Elective Course.

77. **III.** Training Course. — For seniors. Election by permission on History of physical education and supervision of athletics.
2 class hours. Credit,
Professor Hicks.

Women.

Required Courses.

4. **I.** Recreation. — For freshmen. Outdoor games.
3 scheduled hours, credit,
Mrs. Hicks.

5. **II.** Gymnastics. — For freshmen. Dancing, Swedish games, etc.
3 scheduled hours, credit,
Mrs. Hicks.

6. **III.** Recreation. — For freshmen. Outdoor games.
3 scheduled hours, credit,
Mrs. Hicks.

27. **I.** Recreation. — For sophomores. Outdoor games.
5 scheduled hours, credit,
Mrs. Hicks.

28. **II.** Gymnastics. — For sophomores. Dancing, Swedish games, etc.
3 scheduled hours, credit,
Mrs. Hicks.

29. **III.** Recreation. — For sophomores. Outdoor games.
5 scheduled hours, credit,
Mrs. Hicks.

Elective Courses.

50. **II.** Gymnastics. — For juniors. Dancing, Swedish games, etc.
3 scheduled hours, credit,
Mrs. Hicks.

76. **II.** Gymnastics. — For seniors. Dancing, Swedish games, etc.
3 scheduled hours, credit,
Mrs. Hicks.

THE LIBRARY.

The general college library consists of all books belonging to the College, includ-
ıg the Experiment Station and department libraries. A catalogue is maintained ı the main building which lists all books and periodicals belonging to the College, ot only in the main library, but in all branches or department libraries. The brary now includes about 77,000 bound books, together with a great number of nbound books, pamphlets, magazines, and so forth; this more ephemeral litera-ıre in many cases is of great value for research, and is made readily available by ıdexes of many sorts.

Works pertaining to agriculture and related sciences are of course the larger ırt of the collection, but the library is also well supplied with works in literature, istory and sociology. The reading room contains a good collection of encyclo-ədias and general reference books, and the list of periodicals numbers nearly ven hundred, and covers many magazines of general and popular sorts as well s the leading American and foreign publications.

The library is open during terms from 8 A.M. to 10 P.M. daily, and from 10 A.M. 1 P.M. Sundays, with shorter hours during vacations. Visitors are always elcome, and are gladly aided in any problems of research along the lines taught ı the College.

The Graduate School.

Edward M. Lewis, A.M., President of the College.

Charles E. Marshall, Ph.D., Director of the Graduate School and Professor of Microbiology.

Graduate Staff, 1926-1927.

President Lewis, Director Marshall, Professors Alexander, Beaumont, Bradley, Cance, Chambe lain, Clark, Crampton, Fernald, Foord, Frandsen, Glick, Graham, Haskell, Lindsey, Osmu Peters, Sears, Serex, Shaw, Thayer, Torrey, Waugh, Welles; Mr. Hawley, Secretary.

HISTORY AND AIMS.

This college has provided study of a graduate nature for many years. T need for such training became real when agriculture was recognized as an agg gate of the many sciences involved and the many practices employed. The obs lete notion that agriculture is only farming has been replaced by the notion th farming, as such, is only one element in agriculture. The ramifications and di sions of agriculture are many; most of these call for advanced study and traini to meet the exigencies of the times. No apology is, therefore, required for attempt to fathom the scientific, economic and social intricacies of such a func mental phase of human effort as agriculture. The value of such an undertaki is, or should be, patent to every intelligent mind familiar with the situation.

Graduate work has been available to students since 1893. At that time it w possible to qualify for the degree of master of science; later, in 1898, for the degr of doctor of philosophy; in 1913, for the professional degrees of master of agricu ture and doctor of agriculture; in 1916, for the specific professional degree of mast of landscape architecture.

To make the graduate work more effective and distinctive in agriculture, t graduate school was established in 1908. It has become the operating agency f the purpose of fitting graduates of this and other institutions for teaching in co leges, high schools and other public schools; for positions as government, Sta and experiment station specialists in farm management, dairying, livestock hu bandry, poultry science, agronomy, landscape gardening, pomology, vegetab gardening and floriculture; for positions as bacteriologists, botanists, chemis entomologists; for economists and social workers; and for numerous other po tions requiring a great amount of scientific and professional agricultural knowledg training and experience.

ORGANIZATION.

The school is based upon the department as the unit, and the apprenticesh system as the most effective means of instruction. This gives to the stude individuality in treatment and an intimacy with actual conditions of work a operations. The student is assigned to an advisory committee, composed of t instructor in charge of his major subject as chairman, and instructors in char of his minor subjects as members, which directs his graduate studies. The cha men of all these committees together constitute the graduate staff, which contro the policy of the graduate school.

ADMISSION.

Admission to the graduate school will be granted: —

1. To graduates of the Massachusetts Agricultural College.
2. To graduates of other institutions of good standing who have received a chelor's degree substantially equivalent to that conferred by this college.

In case an applicant presents his diploma from an institution of good standing, it has not, as an undergraduate, taken as much of the subject he selects for his ajor as is required of undergraduates at the Massachusetts Agricultural College, will be required to make up such parts of the undergraduate work in that subct as the instructor in charge may consider necessary. He shall do this without edit toward his advanced degree.

Admission to the graduate school does not necessarily admit to candidacy for advanced degree, — students holding a bachelor's degree being in some cases rmitted to take graduate work without becoming candidates for higher degrees.

Applications for membership in the graduate school should be presented to the rector of the school. Full statements of the applicant's previous training, of e graduate work desired, and of the amount and kind of work already done by m as an undergraduate should be submitted, together with a statement whether e applicant desires to work for a degree.

Registration is required of all students taking graduate courses, the first registation being permitted only after the student has received an authorization card om the director.

ATURE, METHODS AND REQUIREMENTS OF GRADUATE WORK.

Graduate work differs from undergraduate work in its purposes and methods. ie primary aims of the instructor are emphasized in an attempt to have the ident adjust himself and place himself in his environment; develop the rule of f-direction and self-instruction; acquire the power of accurate reasoning; gain oficiency and skill in his selected field of study or practice; and obtain an appretive and discriminative insight into experimentation and original research. ethods are not devised, therefore, for attractiveness, entertainment and superial reviews, but for the creation of initiative and profound thought, thorough quaintance with detail, independent advance and industrious habits. Careful dings, lectures, conferences, surveys, laboratory exercises and field work are me of the agencies utilized.

All members of the graduate school are required to attend the course of lectures signed to supplement the technical work of all graduate studies. These lectures ll be given once each week, and the students will be held responsible for the work.

Candidates for the degree of doctor of philosophy are required to prosecute ree subjects, one of which shall be designated as the major and the others as nors. No two of these subjects may be taken in the same department. An origil thesis shall be considered a part of the major subject.

Candidates for the degree of doctor of agriculture are required to select a major d such other subjects as will develop the major in its greatest intensity and comhensiveness. Successful experience is also requisite, together with a thesis ich represents a masterly survey or intimate study through accurate applican of some phase of the major subject.

Candidates for the degree of master of science are required to prosecute two ojects, one of which shall be designated as a major and the other as a minor. hen desirable, and approved by the Director, the minor may be made up of ojects from more than one department. The major and minor subjects may t be selected in the same department. An original thesis is considered a part the major subject.

Candidates for the degree of master of agriculture are allowed greater privileges the selection of subjects, but will be required to select a major and such other pporting lines of study as will be necessary to equip the individual professionally. thesis which will reveal the professional training of the individual will be reired.

Candidates for the degree of master of landscape architecture will be expecte to conform to the established courses of the department, and to the requiremen of the department in the preparation of a thesis, as well as in actual experien outside the college.

Candidates for membership in the graduate school who do not desire to wo for a degree may, with the approval of the director of the school, take more th one subject in the same department, or pursue work in several departments, their preparation will permit. A statement of the subjects chosen must in ea case be submitted to the director of the graduate school for approval. The chos subjects must bear an appropriate relation to each other.

A working knowledge of French and German is essential to successful gradua work, and students not having this will find it necessary to acquire it as soon possible after entering. Other modern languages may be substituted if consider more valuable.

The graduate staff reserves the privilege of recommending and allowing cours in other institutions as a part of residence instruction. Such supervision will exercised and credit granted as are essential to the highest standards of efficienc

THESES.

A thesis is required of each candidate for an advanced degree. It must be on topic belonging to the candidate's major subject; must show that its writer p sesses the ability to carry on constructive study; must be an actual contributi to knowledge; and possess real merit.

The thesis in its final form must be submitted to the director by May 15 of t year in which the student is to present himself for the advanced degree, and befo he may take the required examination. Three complete copies are required. O of the copies is to be retained as an official copy by the director, one is to be dep ited in the college library, and the third is to be retained by the department which the thesis was prepared. The candidate for the doctor's degree must prepared to defend at the oral examination the views presented in his thesis.

FINAL EXAMINATIONS.

For the degree of doctor of philosophy or doctor of agriculture, final examin tions on the minors taken are given upon the completion of the subjects. In t major subject, a written examination, if successfully passed, is followed by an or examination in the presence of the graduate staff.

For the degree of master of science, master of agriculture or master of landsca architecture, a final examination upon the minor taken is given upon the compl tion of each course, and in the major a final examination, which may be eith written or oral, or both, is given over all the work by the department concerned.

DEGREES CONFERRED.

The degrees of doctor of philosophy and doctor of agriculture are conferr upon graduate students who have met the following requirements: —

1. The devotion of at least three years[1] to the prosecution of three subjects study and research in residence at the college.
2. The earning of not less than one hundred credits in the chief or major su ject, and of not less than twenty-five credits in each of two minor subjects.
3. The preparation of a thesis, in the major subject, constituting an actual co tribution to knowledge and accompanied by drawings if necessary. For the degr of doctor of agriculture the thesis may be modified to meet professional requir ments.
4. The passing of final examinations, in both the major and minor subjects, the satisfaction of the instructors in charge.

[1] All time statements refer to minimum time.

5. A public oral examination.

6. The payment of all fees and college expenses required.

The degrees of master of science, master of agriculture and master of landscape :chitecture are conferred upon graduate students who have met the following :quirements: —

1. The devotion of at least one year and a half to the prosecution of study in vo subjects of study and research, not less than one full college year of which .ust be in residence. In the case of a master of landscape architecture the student .ust follow the prescribed course of study.

2. The earning of not less than fifty credits in the chief or major subject, and of ›t less than twenty-five credits in the minor subject. Students pursuing the ›urse in landscape architecture will devote all of their time to the established ›urse, and meet the conditions of one year of experience outside the college.

3. The preparation of a thesis in the major subject, constituting an actual con- ibution to knowledge, and accompanied by drawings if necessary.

4. The passing of final examinations, in both major and minor subjects, to the .tisfaction of the professors in charge.

5. The payment of all fees and college expenses required.

The fee for the degree of master of science, master of agriculture, or master of ndscape architecture is $10, and for the degree of doctor of philosophy or doctor agriculture, $25.

COURSES OFFERED.

Courses available as major subjects for the degree of doctor of philosophy: —

Agricultural Economics.
Agronomy.
Botany.
Chemistry.
Entomology.
Horticulture.
Microbiology.
Pomology.
Rural Sociology.

Courses available as major subjects for the degree of master of science: —

Agricultural Economics.
Agricultural Education.
Agriculture.
Agronomy.
Animal Husbandry.
Botany.
Chemistry.
Entomology.
Horticulture.
Mathematics and Physics.
Microbiology.
Pomology.
Poultry Science.
Rural Sociology.
Veterinary Science.

Courses available as major subjects for the degree of master of agriculture: —

Agronomy. Animal Husbandry. Poultry Science.

The course in Landscape Architecture leads to the degree of master of landscape chitecture.

Courses available as minor subjects: —

Agricultural Economics.
Agricultural Education.
Agriculture.
Agronomy.
Animal Husbandry.
Animal Pathology.
Botany.
Chemistry.
Entomology.
Horticulture.
Landscape Architecture.
Mathematics and Physics.
Microbiology.
Pomology.
Poultry Science.
Rural Sociology.
Zoölogy.

GENERAL OUTLINE OF COURSES FOR ADVANCED DEGREES.

Agricultural Economics.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — Candidates must have had the following courses (their equivalent: Economics and Sociology 50, Agricultural Economics 26 and 5

Required Work. — Candidates must take the following courses: Agricultur Economics 51, 52, 53 and 79. These courses, specially arranged for graduates, ma be taken as Courses 120, 170, 155 and 180 for graduate credit. In addition, ca didates must take Courses 110, 111, 130, 165 and 175 in Agricultural Economic Rural Sociology 27 and 50, or equivalent courses; and Economics and Sociolog 51 and 52, or equivalent courses.

Each candidate will be required to have a working knowledge of the gener field of economics, the history of agricultural economics, the theory of agricultur economics, the problems of agricultural production, land tenure, land problem agricultural commerce, agricultural co-operation, agricultural credit, statistics agriculture, and prices, markets and marketing.

For the Degree of Master of Science.

Prerequisite Work. — The same as for the degree of doctor of philosophy.

Required Work. — The same as for the degree of doctor of philosophy, exce that there is no language requirement.

Graduate Courses Offered.

110. Theory of Agricultural Economics. — Readings in French, Germ and English on economics of agriculture. Alternate years, odd, 200 hours.
Credits,
Professor Cance.

111. Current Economic Problems and Literature. — Department semin throughout the year. Credit, 1 each ter

120. Historical and Comparative Agriculture. — General survey. May taken in connection with Course 51. Spring term, yearly. Credits,
Assistant Professor Sawtelle.

121–122. History of American Agriculture. — Special studies in the hi tory of agricultural institutions, practices or relations. Fall term, even years.
Credits,
Assistant Professor Jefferson.

130. Problems of Agricultural Production. — The relation of the farm to the food supply. May be taken in connection with Course 77. Fall ter yearly. Credits,
Professor Cance.

140. Land Tenure and the Acquisition of Farm Land. — Readings, discu sion, original exercises. Alternate years, even. Credits, 3-
Professor Cance.

145. Farm Labor. — Reading and investigation. Credits,
Professor Cance.

150. Agricultural Commerce, Industry and Trade. — A study of tra movements and commercial activities relating to agricultural products. Fall ter alternate years, odd. Credits, 3-
Assistant Professor Jefferson.

155. The Agricultural Market. — A study of the forces, methods and instiıtions of the market for agricultural products. Spring term, yearly.
Credits, 5.
Professor Cance.

156. Specific Problems in Marketing Farm Products. — Reports and disıssions. Alternate years, odd. Credits, 3.
Professor Cance.

160. Agricultural Prices. — Winter term, yearly. Credits, 3.
Assistant Professor Sawtelle.

161. Agricultural Prices. — Spring term, yearly. Credits, 3.
Assistant Professor Sawtelle.

165. Transportation of Agricultural Products. — Elementary discussion ıd report. Winter term, yearly. Credits, 5.
Professor Cance.

166. Specific Transportation Problems. — Original study, reading and report ı certain transportation problems related to agriculture. Alternate years, odd.
Credits, 3–5.
Assistant Professor Sawtelle.

170. Co-operation in Agriculture. — Elementary problems and discussion. [ay be taken in connection with Course 50. Winter term, yearly. Credits, 5.
Professor Cance.

171–172. Special Problems in Co-operation for Economic Purposes. — ;udy, original investigation and discussion. Every third year, beginning 1922.
Credits, 3–5.
Professor Cance.

175. Agricultural Credit. — Readings and reports in addition to class lecıres on agricultural credit. Taken in connection with Course 78. Spring term, ɜarly. Credits, 3–5.
Assistant Professor Sawtelle.

180. Elementary Principles of Statistics. — Chiefly related to agriculture. ɜctures, laboratory studies and original work. Taken in connection with Course). Fall term, yearly. Credits, 5.
Assistant Professor Sawtelle.

181. Specific Problems in Statistics of Agriculture. — Alternate years, 'en. Credits, 3–5.
Assistant Professor Sawtelle.

185. Rural Law. — Corresponds to Course 78. Spring term, yearly.
Credits, 5.
Mr. Smart.

186. Studies in Agricultural Legislation. Credits, 3–5.
The Department.

190–195. Investigation of Various Problems related to Agricultural ɔonomics. — Credit given on basis of time spent and reports submitted.

200. Thesis. — Research work in agricultural economics will be developed by ur principal methods, namely, historical, statistical, accounting and general ld investigation. In all instances mastery of research methods includes facility ı investigation, tabulation and interpretation of results.

Agricultural Education.

Major Requirements.

For the Degree of Master of Science.

Prerequisite Work. — A minimum of 25 undergraduate credits distributed among the following lines of study: philosophy, psychology, history of education principles and methods of teaching, school organization and administration Successful teaching experience will receive consideration.

Required Work. — At least 50 credits must be earned from the following list of courses in the department or met by accepted transferred credits.

Graduate Courses Offered.

100. History of Education.	Credits, 1–10
104. Vocational Education.	Credits, 1–10
105. Curriculum Study.	Credits, 1–20
110. Rural Education.	Credits, 1–15
115. Vocational Teacher Training.	Credits, 1–10
120. Theory and Use of Mental Tests.	Credits, 1–20
125. Secondary Education.	Credits, 1–15
130. Advanced Educational Psychology.	Credits, 1–20
135. Educational Philosophy.	Credits, 1–20
140. General Educational Research.	Credits, 1–20
145. Teaching Method and Practice.	Credits, 1–10
200. Thesis.	Credits, 15–25

Minor Requirements.

Minor work is offered in the department for the degrees of doctor of philosophy and master of science. Candidates must have had the equivalent of 15 under graduate credits in education.

Agronomy.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — Candidates must have had undergraduate courses 2 and 27 as described in this catalogue, and should have had thorough training in the elements of the natural sciences.

Required Work. — Studies will be assigned from the courses listed below. Thesis problems may be chosen in the subject matter of soils, fertilizers or field crops.

For the Degree of Master of Science.

Prerequisite Work. — As above.

Required Work. — Assigned work will be selected from the courses listed below.

For the Degree of Master of Agriculture.

Prerequisite Work. — The same as for the degree of master of science in so far as it is essential to establish the professional approach to agronomy, but in addition the candidate must be familiar with agronomical practices.

Required Work. — As above.

GRADUATE COURSES OFFERED.

10. STUDIES IN THE CULTURE OF FIELD CROPS. Credits, 5–20.

15. THE FERTILIZATION OF FIELD CROPS. Credits, 5–20.

20. STUDIES IN HARVESTING AND STORAGE. Credits, 5–20.

25. THE IMPROVEMENT OF FIELD CROPS. Credits, 5–20.

30. TECHNOLOGY OF FIELD CROPS. Credits, 5–20.

40. SOIL CLASSIFICATION. Credits, 5–20.

45. STUDIES IN SOIL PHYSICS. Credits, 5–20.

50. MOISTURE RELATIONSHIPS IN SOILS. Credits, 5–20.

55. STUDIES IN SOIL MANAGEMENT. Credits, 5–20.

60. SOIL TECHNOLOGY. Credits, 5–20.

70. STUDIES IN SOIL FERTILITY. Credits, 5–20.

80. FERTILIZER TECHNOLOGY. Credits, 5–20.

90. STUDIES IN LITERATURE. Credits, 5–20.

00. THESIS. Credits, 15–50.

MINOR REQUIREMENTS.

Prerequisites are as stated for major work. In addition studies suited to the eeds of the candidate will be selected from the above courses.

Animal Husbandry.

MAJOR REQUIREMENTS.

For the Degree of Master of Science or Master of Agriculture.

PREREQUISITE WORK. — Candidate must have had the following courses, or ıeir equivalents, before he can enter graduate work in this department: Animal Iusbandry 25, 26, 50, 51, 52, 53, 75 and 78. He should also be able to show evience of experience in practical animal husbandry.

REQUIRED WORK. — At least 50 credits must be earned from the following list f courses offered by the department.

GRADUATE COURSES OFFERED.

00. ADVANCED BREED HISTORY. Credits, 10.

10. NUTRITION OF FARM ANIMALS. Credits, 10.

20. REPRODUCTION OF FARM ANIMALS. Credits, 10.

00. THESIS. Credits, 25.

MINOR REQUIREMENTS.

Minor work in animal husbandry may include undergraduate Courses 50, 51, 3, 81 or 82, and such other work in reading and compilation of material as the ıstructor may outline. Written examinations will be conducted at the completion of each term's work.

Animal Pathology.

MINOR REQUIREMENTS.

Minor work in animal pathology for the degrees of doctor of philosophy and ıaster of science consists of an especially planned course for graduate students. This is not an undergraduate course, but is arranged to meet the needs of graduate students who have not pursued a course in general pathology. It will continue throughout the year and include reviews in gross and microscopic anatomy, physiological, bacteriological, serological, biochemical and morbid anatomical phases of pathology. Written examinations will be given at the end of each term.

100. General Pathology. — As described above, fall term. Credits, 5

120. General Pathology. — Continuation of 100, winter term. Credits, 5

140. General Pathology. — Continuation of 120, spring term. Credits, 5

160. Biochemical Phases of Pathology. — Second year, fall term. Credits, 5

180. Pathological Histology. — Second year, winter term. Credits, 5

Professor Gage.

Botany.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — The equivalent of certain undergraduate courses, determined by the department in the case of each student, is prerequisite.

Required Work. — Candidates will be required to take Courses 100 through 107 and 180, 190 and 200. Courses 150 through 155 may be taken for graduate credit in certain cases. The maximum number of major credits which may be earned in this way is thirty-two.

For the Degree of Master of Science.

Prerequisite Work. — The requirements are the same as for the degree of doctor of philosophy.

Required Work. — Candidates will take Courses 100 and 101 and all courses from 102 through 107 which are given during their term of residence, also 180, 190 and 200. In certain cases Courses 150 through 155 may be taken, but not more than 20 credits may be earned in this way.

Graduate Courses Offered.

Courses 100 through 106 are lecture courses. They are given in rotation, except Courses 100 and 101, which come every year.

100. Plant Physiology. — The lectures will consider, under the nutrition of the plant: its chemical structure, absorption of various nutrient substances and their changes in the plant, assimilation and dissimilation of carbon and nitrogen by autotrophic and heterotrophic plants; under changes in the form of plants growth and form under constant external factors, the influence of variable external and inner factors on growth, form and development; and under plant movements the various tropisms, nutations, etc. Supplemental demonstrations, laboratory work and readings in the standard texts and journals. One lecture a week for 36 weeks. Credits, 3

101. Plant Pathology. — A general consideration of the history, nature and causes of plant disease; parasitism, predisposition, immunity, degeneration, natural and artificial infection, dissemination, epidemics, biologic strains, monstrosities and malformations, proliferation, prevention and control, economics of plant diseases. One lecture a week for 36 weeks. Credits, 3.

102. Plant Inheritance. — This course is planned to give the student a comprehensive understanding of the principles and facts of plant inheritance. A study is made of plant variations, Mendel's law of heredity, the physical basis of heredity as established by chromosome behavior, pure lines, mutations, species and graft hybrids, etc. One lecture a week for 12 weeks. Credit, 1.

103. Biologic Relations. — Consideration of certain phases of the morphological and physiological adaptations of plants with regard to insect visit; the rôle of thorns, hairs, tendrils, glands, etc. Various experiments are made to test out experimentally some of the existing theories concerning biologic adaptations. One lecture a week for 12 weeks. Credit, 1.

104. The Ecology of Plants. — This course deals with the water, light and temperature relations of plants, and the various adaptations in response to these factors; the various types of plant formation; the migration of plants; the competition of plants; invasion and successions of plants under varied conditions; and the various types of alternations and zonations. One lecture a week for 12 weeks. Credit, 1.

105. Physiological Plant Pathology. — This course considers those plant diseases not due to bacterial or fungous parasites, but resulting from unfavorable physical or chemical conditions of the soil; from harmful atmospheric influences, such as too dry air, too much moisture, hail, wind, lightning, frost; from injurious gases and liquids; from lack of or too much light; from wounds. A knowledge of the normal physiology of the plant is required. Demonstrations and laboratory work will be given, together with assigned readings. One lecture a week for 12 weeks. Credit, 1.

106. History of Botany. — An historical survey of the science; lives of noted botanists; history of certain culture plants, such as wheat, corn, coffee, potato, rice, and their influence on civilization; reading. One lecture a week for 24 weeks. Credits, 2.

107. Methods in Drawing and Photographing for Thesis and Publication. — Twelve weeks. Credits, 1–3.

108. The Comparative Anatomy of Green Plants. — See undergraduate Courses 61–63.

150. Systematic Mycology. — See undergraduate Courses 52–54.

151. Systematic Botany of the Higher Plants. — See undergraduate Courses 58 and 59.

152. Plant Histology. — See undergraduate Course 55.

153. Cytology and Embryology. — See undergraduate Courses 82 and 83.

154. Plant Pathology. — See undergraduate Courses 75–77.

155. Plant Physiology. — See undergraduate Courses 78–80.

180. Seminar. — A weekly seminar for members of the department staff, graduate students and major senior students is held, at which important botanical papers are discussed. Attendance and participation are required. Credits, 3.

190. Collateral Reading. — Extensive reading of botanical literature in English, German and French, designed to give the student a broad knowledge of the science, is required of all major students. Final examinations are based in part upon this reading course. Credits, 5–10.

200. Thesis. — Each major student is required to select a problem in plant pathology or physiology (in other branches at the discretion of the department) for original investigation, and the thesis must embody a distinct contribution to knowledge. An effort will be made to assign problems having some bearing on scientific and economic agriculture. The thesis work counts for not more than 50 per cent of the total number of major credits required for either degree.

Minor Requirements.

For a minor a student may take such of the work offered by the department as seems best suited to his major course. Courses 150 and 155 are primarily undergraduate work which may be taken for minor credit toward advanced degrees. In most cases no problem will be assigned.

Professors Osmun, Clark, Torrey, Doran and Davis.

Chemistry.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — The candidate must have taken undergraduate Courses 1 to 87, or their equivalent.

Required Work. — The candidate will be required to take all the graduate courses listed below. He may also be required to spend at least one year at some other recognized institution, pursuing graduate study in chemistry. For the final examinations, questions will be selected from the entire field of chemistry, with special emphasis upon the lines of work covered by the research.

For the Degree of Master of Science.

Prerequisite Work. — The same as that required for the degree of doctor of philosophy.

Required Work. — The candidate will be required to take Courses 101 and 108 through 114. In addition he will pursue the requirements of one of the following thesis subjects: —

Organic and Biochemistry. — Course 200 and either 105 or 106, and 103) or (*f*), and 104.

Analytical and Industrial Agricultural Chemistry. — Courses 200, 103 (one course), 102, 104, 105, 106.

Physical Chemistry. — Courses 200, 104, and one course selected from 1, 103, 105, and 106.

Agricultural Chemistry. — Courses 200, 103 (one course), and one course selected from 102, 104, 105 or 106.

The candidate must pass a final written and oral examination before the department upon undergraduate Courses 1 through 80, as well as upon all graduate work taken in chemistry.

Graduate Courses Offered.

101. Inorganic Preparations. — Laboratory. The preparation of chemical products from raw materials. The manufacture and testing of pure chemicals. The laboratory work is essentially synthetic in nature, and is designed to aid in acquiring a more adequate knowledge of inorganic chemistry than is to be obtained by chemical analysis alone. Ten to fifteen of the preparations given in Biltz's "Laboratory Methods of Inorganic Preparations" will be made by each student. Any term. Credits, 3.

Assistant Professor Serex.

102. Advanced Inorganic Preparations. — Laboratory. Continuation of Course 101. Any term. Credits, 3.

Assistant Professor Serex.

103. Advanced Analytical Chemistry. — Laboratory. This course may be taken in part as follows: (*a*) electrolytic analysis, 6 credits; (*b*) ultimate analysis, 3 credits; (*c*) special analytical work to meet the needs of the individual student, 5 credits. In addition the following subjects may be taken if desired: (*d*) fertilizers, 5 credits; (*e*) insecticides, 3 credits; (*f*) milk and butter, 6 credits. (*a*), (*b*), (*c*) may be taken any time; (*d*), (*e*), (*f*) should be taken at the time the undergraduate course is given.

Professor Peters.

104. Advanced Physical Chemistry. — Laboratory. Measurement of the electrical conductivity of solutions; degree of ionization; ionization constants; per cent hydrolysis of aniline hydrochloride from conductivity measurements; solubility product by the conductivity method; velocity of saponification by conductivity; neutralization point by conductivity; vapor pressure determinations; critical temperature of carbon dioxide or sulphur dioxide; transport numbers; preparation and properties of colloidal solutions; transition points by dilatometric method; heat of solution of ammonium chloride and potassium nitrate; adsorption of iodine by charcoal; determination of hydrogen ion concentration. To each student separate work will be assigned. Any term. Credits, 5.

Assistant Professor Serex.

105. Advanced Organic Chemistry. — Laboratory. The preparation of compounds not included in Courses 51 and 52, such as the Kolbe synthesis of salicylic acid; benzophenone and Beckmann's rearrangement; rosaniline, malachite green, Congo red, indigo and other dyes; synthesis of fructose; Grignard reaction. Barnett, Cain & Thorpe, Gattermann, Noyes, Fischer and other laboratory guides are used. To each student separate work will be assigned. Any term. Credits, 5.

Professor Chamberlain.

106. Advanced Physiological and Food Chemistry. — Laboratory. An intensive study of some of the more important physiological processes, physiological compounds or food ingredients. Studies of milk, blood, urine or other physiological factors under various metabolic and pathologic conditions. To each student separate work will be assigned. Any term.

Prerequisite, Chemistry 80. Credits, 5.

Dr. Butler.

108. Theoretical Chemistry. — Lectures. The following topics are considered: the compressibility of the atoms; the structure and size of atoms; the electron conception of valence. Third term. Alternates with Course 109.

Credits, 2.

Professor Peters.

109. Analytical Chemistry. — Lectures. A general survey of methods and technique covering processes commonly carried out in the laboratory. Third term. Alternates with Course 108. Credits, 2.

Professor Peters.

110. Organic Chemistry. — Lectures. Some of the following topics will be considered both theoretically and industrially: alkaloids, synthetic dyes, essential oils, terpenes, rubber, etc.; the study of methods for carrying out general reactions; isomerism, tautomerism, condensation, etc. References: Cain & Thorpe, Cohen, chemical monographs, Lassar-Cohn, Heinrichs, Molinari. First term. Credits, 2.

Professor Chamberlain.

111. Advanced Physiological and Food Chemistry. — Lectures. A study of the recent advances in this field. An intimate treatment of the more important physiological factors and their relations to health, nutrition and growth. Second term.

Prerequisite, Chemistry 80. Credits, 2.

Dr. Butler.

112. Theoretical and Physical Chemistry. — Lectures. The relation between the constitution and properties of compounds; mutarotation; steric hindrances; stereoisomerism of other elements than carbon; molecular association; similarity between the compounds of silicon and carbon. Third term. Alternates with Course 113. Credits, 2.

Assistant Professor Serex.

113. THEORETICAL AND PHYSICAL CHEMISTRY. — Lectures. A general outli of radioactivity and colloid chemistry. Third term. Alternates with Cou 112. Credits,

Assistant Professor SEREX.

114. SEMINAR. — Conferences, reports or lectures. Three terms, twice a mont. Credit,

Professor LINDSEY.

200. THESIS. — Research, and, in the case of a degree, the preparation of acceptable thesis in agricultural, analytical, organic or physical chemistry, und the direction of the professor in charge of the work. Credit determined by wo done.

MINOR REQUIREMENTS.

Work may be selected from any of the undergraduate Courses 51 to 87, or a of the graduate courses for which the student is prepared. In addition, the can date may be required to pass a final written and oral examination before the depa ment upon his entire minor work.

Entomology.

MAJOR REQUIREMENTS.

For the Degree of Doctor of Philosophy.

PREREQUISITE WORK. — Students must have had all the undergraduate cour given at this college or their equivalent. Opportunities to make up any deficienc will be available while the graduate work is being carried on.

REQUIRED WORK. — The graduate courses consist of lectures on all, and labo tory work on a part, of the subjects given below, together with advanced readin seminar work and original research.

For the Degree of Master of Science.

PREREQUISITE WORK. — The same as for the degree of doctor of philosophy.

REQUIRED WORK. — A major course for the master of science degree will about half of the courses listed below.

GRADUATE COURSES OFFERED.

100. MORPHOLOGY. — 1. Embryonic development of insects and polyembryon
2. Metamorphosis and its interpretations.
3. Advanced external and internal anatomy.
4. Insect histology and physiology.
5. Ancestry and development of insects, including fossil insects.
6. Hermaphrodites in insects.
7. Hybrids.
8. Parthenogenesis, pedogenesis and heterogeny.
9. Chemistry and physics of insect colors.
10. Color patterns, their significance and value.
11. Luminosity.
12. Deformities.
13. Variation in insects.

120. ECOLOGY. — 1. Dimorphism and polymorphism.
2. Mimicry, including concealment, protective devices and warning coloratio
3. Architecture of insect structures.
4. Relation of insects to plant fertilization and its importance.
5. Insect products of value to man.
6. Geographical distribution and methods of distribution of insects, with a co sideration of life zones, barriers, etc.
7. Insect migrations.

8. Insect behavior and experimental entomology.
9. Enemies of insects.
10. Duration of life.

140. Economic Entomology. — 1. Control methods.
2. Insect photography and methods of preparing illustrations.
3. Field work and life history investigations with methods for keeping records.
4. Legislation about insects.
5. Studies of insecticides and their application.

160. Systematic Entomology. — 1. History of entomology and of classifi-ations.
2. Lives and works of prominent entomologists.
3. Abundance of insects.
4. Important collections, public and private; their location and their value.
5. Types of insects; their significance, importance and location.
6. Rules of nomenclature and how they are used.
7. Methods for collecting, preparing, preserving and shipping insects.

180. Seminar. — Readings and reports on the current literature of entomology; ıonthly meetings.

190. Collateral Readings. — The best articles on the various topics in en-ɔmology are assigned for collateral readings, and are included in the final exam-ıations.

200. Thesis. — Original research on one or several topics in morphology, ecology, ɔonomic and systematic entomology. This is expected to require from one-half ɔ three-quarters of the total working time of the student.

Minor Requirements.

Minor courses will cover such parts of the work outlined above as will be most kely to prove useful in connection with the majors taken by the students, or in ıeir future work. It is not required that such men shall have had all the under-raduate work in entomology given at this college, their credit for a minor begin-ing where their own undergraduate training in the subject ended.

Horticulture.

Graduate work is offered in various lines of horticulture. For the most part ıis is divided into the different departments which constitute the college Division Horticulture, as follows: pomology, floriculture, landscape gardening, forestry ıd market gardening. For work in these lines application should be made direct the heads of the several departments.

Besides this work, however, opportunity is offered for graduate study in general ɔrticulture, including topics from the several organized departments mentioned, ıd also questions relating to plant breeding, general evolution, propagation, anufacture of horticultural products, etc. This general work is under the direc-ɔn of Professor Waugh, head of the Division of Horticulture.

Landscape Architecture.

Major Requirements.

For the Degree of Master of Landscape Architecture.

Prerequisite Work. — The undergraduate courses in the college known as andscape Gardening 50, 51 and 52, Drawing 25, 26 and 27, Horticulture 50 and l, and Mathematics 26 and 27 will be considered prerequisite to graduate work, ıd any student who has not passed these courses, or their equivalent, will be ıquired to make up such work without graduate credit.

Required Work. — Each student before he may receive the master's degree with a major in this department must convince his instructors that he has a genuine aptitude for some branch of landscape gardening, either in design, construction or management.

The minimum period of graduate study will be one and one-half years. At least one year of this time must be spent in residence at the college. One year must also be spent in practice outside the college. The work done outside the college may be prescribed by the department, and must be fully reported to the department in writing. It is essential, further, that the candidate secure the written approval of his employers outside the college. The department may, at its discretion, require a longer period of study at the college or a longer apprenticeship outside the college.

Every student before receiving his master's degree in landscape architecture must have given some thorough and fruitful study to each of the following five departments. As far as possible these studies must be of a practical nature, i.e., they must be made upon actual projects in progress of development.

1. *Theory.* — The principles of esthetics as applied to landscape architecture.
2. *Design.* — The principles of pure design and their application in landscape and garden planning.
3. *Construction.* — The practical methods of carrying out landscape plans, laying out, equipment, organization of working force, time and cost keeping, etc.
4. *Maintenance.* — Methods, organization, cost.
5. *Practice.* — Office work, drafting, estimating, reporting, charges, accounting.

While great freedom is allowed to graduate students in their plans of work a certain portion of time will always be given to systematic courses of instruction. Courses known as Landscape Gardening 175, 176, 177, 178, 179, 180, 181 and 182 are required, and may or may not be accepted for graduate credit, at the discretion of the department.

Graduate Courses Offered.

175. Theory of Landscape Art. — Same as Landscape Gardening 75. First term. Credits 3.
Professor Waugh.

176. Civic Art. — Same as Landscape Gardening 76. Second term. Credits 3.
Professor Waugh.

177. Country Planning. — Same as Landscape Gardening 77. Third term. Credits 3.
Professor Waugh.

178. Architecture. — Same as Landscape Gardening 78. Third term. Given in alternate years. Credits, 3.
Assistant Professor Harrison.

179. Construction. — Same as Landscape Gardening 79. Third term. Given in alternate years. Credits, 3.
Assistant Professor Harrison.

180. Theory of Design. — Same as Landscape Gardening 80. First term. Credits, 3.
Professor Waugh.

181. Estate Design. — Same as Landscape Gardening 81. Second term. Credits, 3.
Assistant Professor Harrison.

182. Park Design. — Same as Landscape Gardening 82. Third term. Credits, 3.
Assistant Professor Harrison.

190. Theory. — Special studies. Credits, 2–10.
The Department.

191. Design. — Individual problems by arrangement. Credits, 2–10.
The Department.

192. Construction. — Individual problems by arrangement. Credits, 2–10.
The Department.

193. Maintenance. — Special studies, experimental work of assigned problems.
Credits, 2–10.
The Department.

194. Practice. — Professional field work under supervision. By arrangement.
Credits, 2–10.
The Department.

195. Seminar. Credits, 1–5.
Professor Waugh.

200. Thesis. — Each student before receiving the master's degree with a major landscape architecture must present a satisfactory thesis or complete project. thesis will consist of a careful original study of some problem in landscape archicture, presented in typewritten form with any necessary illustrations, such as iotographs, diagrams, drawings, etc. A project will consist of a completed set of ıdies of some suitable landscape-gardening problem, such as the design of a ırk, a real estate subdivision, an extensive playground. Such a project will usuly consist of —

(a) Original surveys, including topography.
(b) Block plans, showing original design.
(c) A rendered plan or plans of the main features.
(d) Detailed working drawings.
(e) Estimates of cost.
(f) Complete report and letter of transmittal.

Credits, 5–20.

Minor Requirements.

Any student electing a minor in landscape architecture will be directed to take ch courses from the regular catalogue list as may seem most suitable to him. ıder ordinary circumstances no other work will be given to students electing inors. In special cases, however, individual problems will be assigned and indidual instruction given. These exceptions will be made in cases where, by so ing, it is possible to give the student material assistance in the plan of his major ork.

Microbiology.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — Candidate must have had Courses 50, 51, 52, 80, 81, and 83, or their equivalents, before he can enter upon graduate work.

Required Work. — Studies will be selected from the courses offered below. will be the purpose of the department to distribute such studies among the urses offered in a manner to gain the greatest efficiency and a comprehensive owledge of the entire field. The work will be conducted by prescribed readings, tical written reviews, conferences, lectures and laboratory exercises.

For the Degree of Master of Science.

Prerequisite Work. — The same as for the degree of doctor of philosophy.

Required Work. — Courses of a basic and applied character selected from the urses offered below which will prepare the student for effective effort.

Graduate Courses Offered.

100. History of Microbiology. Credits, 5-[cut off].

110. Cytological and Morphological Studies and Corresponding Te[cut off]nique. Credits, 5-[cut off].

120. Studies in Technique and Methods. Credits, 5-[cut off].

130. Physiological Studies. Credits, 5-[cut off].

135. Industrial Fermentations. Credits, 5-[cut off].

140. Agricultural Microbiology — General Survey. Credits, 5-[cut off].

141. Microbial Studies in Agriculture. Credits, 5-[cut off].

150. Soil Microbiology. Credits, 5-[cut off].

160. Dairy Microbiology. Credits, 5-[cut off].

170. Food Microbiology. Credits, 5-[cut off].

180. Hygienic Microbiology. Credits, 5-[cut off].

181. Special Sanitary or Hygienic Studies. Credits, 5-[cut off].

190. Lectures and Study of Literature. Credit, 1 each te[cut off].

200. Thesis. — Some microbiological problem related to agriculture or fo[cut off]. Distributed as may be most beneficial for research work. Time and credit [cut off] arrangement. Credits, 15-[cut off].

Minor Requirements.

Minor work in microbiology may consist of undergraduate Courses 50, 51, [cut off], and other courses designed to support the major work, from among the cour[cut off] offered above. The candidate will also be required to pursue graduate Course 1[cut off], or follow a course of reading and conferences through three terms. In case [cut off] candidate has had some of these courses, he will be required to take more advan[cut off] substitute courses.

Pomology.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — Candidates must have had the equivalent of the cour[cut off] required for graduation from this college; also sufficient practical experience [cut off] enable them to understand and appreciate the problems of orchard practice.

Required Work. — The work outlined below will be required of all candidat[cut off].

For the Degree of Master of Science.

Prerequisite Work. — The same as for the degree of doctor of philosophy[cut off]

Required Work. — One-half of the work outlined below, selected to meet t[cut off] needs of the individual student, will be required.

Graduate Courses Offered.

101. Experimental Methods. Credits, 15-[cut off].

A critical study of the methods of research that have been used or may be he[cut off]ful in pomological work. The following topics will be considered from the po[cut off] of view of the investigator in pomology.

1. Statistical methods.
2. Measures of growth and yield.
3. The conduct of plot experiments.

4. Methods of soil study in their relation to pomological research.
5. Chemical methods of pomological research.
6. Methods of physiology applicable to fruit plants.
7. Microchemistry.

102. Pomological Research. Credits, 15–20.

A critical survey of past and current research work in pomology. Semi-weekly eetings for reports and discussions will be held. The following topics will be ken up.

1. Orchard soil management.
2. Soil fertility and fertilizers.
3. Physiology of pruning tree fruits and bush and vine fruits.
4. Fruit bud differentiation.
5. Sterility and Fertility.
6. Genetics of fruit plants.
7. Climatology and winter injury.
8. Advanced morphology.
9. Spraying machinery and equipment.
10. Special practices.

103. Advanced Laboratory Work. Credits, 5–12.

Each student will be required to become familiar with the research work of the partment and to have a share in it. So far as this has value as graduate work he ill receive credit.

104. History of Pomology. Credits, 2–5.

The men, institutions and other influences that have contributed to the devel-ment of the science and art of pomology.

105. Horticultural Taxonomy. Credits, 2–3.

A study of the history and development of plant classification with special refer-ce to horticultural plants. A study of modern classification carries with it an pression of opinion as to the evolution of cultivated plants.

106. Advanced Systematic Pomology. Credits, 6–10.

The principles of systematic pomology including a study of nut and subtropical uits not usually dealt with in undergraduate courses.

200. Thesis. Credits, 40–50.

Each student will be required to carry out an original investigation of an assigned oblem. In the planning, executing and interpreting the data of this problem he ust show marked ability. The results are embodied in a thesis to be passed upon the Department and the Graduate Staff.

Minor Requirements.

Students taking a minor in pomology will select such of the above courses as ay be suited to their needs. Certain advanced undergraduate courses may also taken for minor credit.

Poultry Science.

Major Requirements.

For the Degree of Master of Science or Master of Agriculture.

Prerequisite Work. — The postgraduate course presupposes all undergrad-te work or its equivalent, together with practical experience. Without the latter, idents will be unable to handle Courses 140, 150 and 160. At the discretion of e instructor in charge, graduate students may be required to pursue under-aduate courses in other departments without credit.

Required Work. — All the courses listed below. Practical poultry work may required, but no credit will be given for such work.

Graduate Courses Offered.

101. Reading. — A review of the entire field of poultry literature, covering books, bulletins and special articles, is made, and a written report on one or more subjects required.

110. Seminar. — A critical review and a criticism of the more important experiments carried on at various stations in this and other countries; also a study of poultry conditions in foreign countries, methods of management, etc., besides a detailed study of some of the largest poultry projects in this country.

120. Anatomy (Gross and Histological), Physiology and Surgery.— This course requires a careful study of the anatomy and physiology of the fowl. Special attention is given to a study of those structures concerned with practical poultry problems. Instruction in surgical technique, adapted to fowls, may also be given.

130. Breeding. — The student will carry on such breeding experiments as time and facilities permit. He may also do work in connection with our regular experimental projects. A detailed study of the pertinent literature will be required. Animal Husbandry 5, or its equivalent, is a prerequisite.

140. Feeding. — A study of the relation of various foods and other substances to the morphology and physiology of the bird, with special reference to such subjects as egg production, feather form and structure, condition of flesh, bone, etc.

150. Brooding. — Studies will be made upon the relation between viability and rate of growth and the following topics: type of brooder, number of chicks in brood, ventilation, humidity, sanitation, exercise and weather conditions; also a comparison of natural methods with artificial methods of rearing chicks.

160. Incubation and Embryology. — A number of problems of a practical, scientific and mechanical nature relating to incubation are considered. The work in embryology is of an advanced nature, dealing with its relation to morphogenesis and heredity, and presupposes an elementary knowledge of the embryology of the chick.

170. Poultry Diseases and Sanitation. — In this course a study is made of various problems in poultry sanitation, with particular reference to methods relating to the control and eradication of disease.

200. Thesis.

Minor Requirements.

Courses 101 and 110 are designed particularly for minors.

Rural Sociology.

Major Requirements.

For the Degree of Doctor of Philosophy.

Prerequisite Work. — Candidates must present satisfactory evidence of having completed at least 10 credit hours in general sociology and 10 credit hours in general economics; or take such undergraduate courses as the department may designate to satisfy this requirement.

Required Work. — Candidates must take or pass by satisfactory examination courses offered by the department for undergraduates bearing the numbers 26, [illegible], 51, 52 and 75, and such courses in agricultural education and agricultural economics as may be required, not to exceed 10 credit hours in each department. Candidates will be required to select from the courses listed below as graduate courses a field for investigation and intensive study. Candidates for the doctorate must take all courses listed as graduate.

For the Degree of Master of Science.

Prerequisite Work. — The same as for the degree of doctor of philosophy.
Required Work. — Not less than 50 credit hours will be required from the urses listed below. The department will make such selection as may best meet interest of the individual student.

Graduate Courses Offered.

177. Field Work of an Investigational Nature.

178. Rural Social Surveys.

179–181. Seminar.

182. Social Conditions of American Rural Life.

183. Social Conditions of European Rural Life.

184. Rural Institutions.

185. Rural Organization.

186. Farmers' Organizations.

187. Town and Village Rural Life.

188. Rural Health and Sanitation.

189. Rural Literature.

190. Rural Government and Law.

200. Thesis.

Veterinary Science.

Work is available in hygiene, veterinary pathology, and other special lines or isions of the subject.

Zoölogy.

Minor Requirements.

Courses in zoölogy may be available as a minor for the degrees of doctor of losophy and master of science. The nature of the work will necessarily vary ording to circumstances, and may be intensive in a special field and correlated sely with the major work of the student, or it may be of a more general char-er, depending on the student's needs or previous acquaintance with general logical science.

The Short Courses.

The short courses offered by the Massachusetts Agricultural College are design to meet the needs of those, both young and old, who cannot come to the colle for the regular college courses. They furnish the student with instruction modern accepted methods, and are planned to help the farmer and the housewi

The short courses include: —

A. The Two-Year Course in Practical Agriculture.
B. The Ten Weeks' Winter School.
C. The Summer School.
D. The Vocational Poultry Course.

Requirements for Admission to Short Courses. — Students must be least seventeen years of age, and must furnish satisfactory evidence of good mor character. References are required. There are no entrance examinations. T sole test is ability to do the prescribed work. Students enrolling for the Tw Year Course in Practical Agriculture must have at least a common school educatio

Expenses of Short Courses. — The expense of attending any of the sho courses is approximately as follows: —

Furnished rooms in private houses (per week)	$3 to $5
Board at college dining hall (per week)	$8
Board with private families (per week)	$6.50 to $9
Registration fee (Ten Weeks' Winter School)	$5
Tuition fee (Winter School and Summer School)	$10
Tuition fee (Two-Year Course) (per term)	$20

In addition small laboratory fees are charged in some of the courses.

A. TWO-YEAR COURSE IN PRACTICAL AGRICULTURE.

The Two-Year Course in Practical Agriculture is offered to meet the needs students who for one reason or another cannot take the four-year college cours It is designed to provide a large amount of practical information and traini in agriculture and horticulture.

It will appeal, not only to young men and women, but also to men and wome of mature years and practical experience who wish to know more about the busine of farming. Although the course is planned to meet the needs of those who a not graduates of high schools, the instruction is not preparatory or elementa in its nature, but is so planned that it will be of value to all. The greater amou of academic training that some of the students may possess will in a measure b offset by the fund of practical knowledge possessed by many who have complete only the elementary schools.

The course is not intended for students enrolled in high schools. Such studen should finish the high school course. Students enrolled in high schools who wis to take the course should bring a statement either from the principal of the hig school or from parent or guardian asking permission to be enrolled.

The Two-Year Course in Practical Agriculture is arranged so as to provi specific vocational training for the particular lines of agricultural work which th dents may select. When a student enrolls he is required to state the type of ming in which he expects to engage; and to select from the following courses study the one he wishes to pursue: —

1. General agriculture, with animal husbandry as the principal subject.
2. General agriculture, with poultry as the principal subject.
3. Dairy manufactures.
4. General horticulture.
5. Fruit growing.
6. Floriculture.
7. Vegetable gardening.

He then pursues a specially arranged course of preparation for that type of rk. This specialization does not prevent his securing a general working knowl-ge of other subjects in which he may be interested.

The advantages of the college staff of specialists and the college plant with its resources are thus made available to young men and young women who y not have had the opportunity of securing a high school education.

The first year consists of six months of study at the college. The term begins first Monday in October and closes with the winter term of the regular session. e same vacation periods are observed as in the regular four-year course.

At the close of six months of study, students are required to gain six months farm experience. The college will assist students in finding positions and in cing them on farms where the experience gained will be of great advantage. us an effort will be made to place on a dairy farm the man expecting to take up irying as his chief line of work, and a student of pomology on a fruit farm.

During the second year the student spends nine months in resident study, npleting the subject pursued in the first year.

Each student is required to file with the treasurer of the college a statement, ned by the town (or city) clerk of the town (or city) from which he enrolls, ting that the parent or guardian of the student is a resident of that town.

Certificate. — Students completing satisfactorily work prescribed in the o-Year Course will receive certificates.

Credits earned in the Two-Year Course in Practical Agriculture or in any other the short courses except the Summer School, do not lead to the college degree.

Tuition. — A tuition fee of $20 per term is charged to all students who are idents of Massachusetts. Students who are not residents of Massachusetts charged a tuition fee of $60 a term.

B. THE WINTER SCHOOL.

The Winter School, beginning usually about January 1 and continuing for ten eks, was started several years ago, and has always been very popular, not only h more mature farmers and their wives, but with young men and women who ntrol or manage farms. The courses, though short, are very practical in their ure, and are so arranged that a student may choose such subjects as will enable n to specialize along the line of work in which he is most interested. There is a le range in the choice of subjects, making it possible for the student to take rk for several winters in succession. Many college graduates enroll for the Winter hool.

Scholarships. — The Jewish Agricultural and Industrial Aid Society of New rk has instituted a system of free scholarships to enable the children of Jewish mers to attend the short winter course in the States in which they reside. The pend is sufficient to pay all the expenses of the holder for the course. Such penses usually amount to from $100 to $150. The following courses are offered: —

Outline of the Ten Weeks' Winter School, January 3 to March 11.

l Fertility. Two lectures and one two-hour laboratory period per week.
ld Crops. Two lectures and one two-hour laboratory period per week.
pes and Breeds of Livestock. Three lectures and two two-hour laboratory periods per week.

Livestock Feeding. Three lectures per week.
Animal Breeding. Three lectures per week.
Dairy Bacteriology. Two lectures and one two-hour laboratory period per we
Animal Diseases and Stable Sanitation. Five lectures per week.
Poultry Husbandry. Five lectures and one two-hour laboratory period per we
Poultry Diseases. Two lectures and one two-hour laboratory period per we
Vegetable Gardening. Three lectures and two two-hour laboratory periods p week.
Floriculture. Five lectures per week.
Horticultural Manufactures. Two lectures and two two-hour laboratory peri s per week.
Farm Management. Two lectures per week.
Farm Accounts. Two two-hour laboratory periods per week.
Farm Motors. Three lectures and two two-hour laboratory periods per week.
Marketing. Two lectures per week.
Botany. Two lectures per week.
Entomology. Three lectures per week.
Rural Sanitary Science and Hygiene. Two lectures per week.
Agricultural Opportunities for Women. Two lectures per week.
Food for the Family. Two lectures and three two-hour laboratory periods per we
Clothing for the Family. Two lectures and three two-hour laboratory periods p week.
Family Health. Three lectures per week.
Home Management. Five lectures per week.
Principles and Methods of Teaching. Five lectures per week.
Special Methods in Vocational Agricultural Teaching. Five lectures per week
Agricultural Teaching Improvement Problems in Massachusetts. Five peri s per week.

Ten Weeks' Winter Course in Fruit Growing. — A specialized course in fr t growing intended for persons who are interested in the growing of fruit for pro

The work will require practically all of the student's available time while t the college and every student is expected to take all the courses offered.

Enrollment is limited to fifteen students.

Courses Offered.

I. Tree Fruits.
II. Pruning.
III. Spraying.
IV. Small Fruits.
V. Harvesting and Marketing.
VI. Farm Motors.

Ten Weeks' Course For Greenskeepers. — A specialized course for men engag in the profession of greenskeeping, or members of greens committees. This cou has been arranged in co-operation with the New England Greenskeepers' Cl and the subjects as outlined can be effectively studied during the winter months

Applicants for this school must be members of the greens committee, gree keepers, or must have had at least one year's experience on a golf course, and th application blanks must be countersigned by the greenskeeper and chairm of the greens committee.

No entrance examinations are required, but it is expected that the stude will have a reasonable education in the English language.

The number of students is limited to ten, and registration will be confined citizens of Massachusetts until December 1, 1926. After that date, if there vacancies, out-of-state students will be admitted in order of the filing of th applications.

The college reserves the right to reject any applicant obviously unqualifi for the work, or to dismiss any student for misconduct, or failure to proper meet the requirements of the course.

Applicants may register for one or more of the courses offered, but will not be rmitted to enroll after the course has started.

The winter school certificate will be given to those who complete the full course th credit.

Courses Offered.

I. Motors.
II. Water Systems.
III. Soil Fertility.
IV. Equipment.
V. Reference Reading and Record Keeping.
VI. Grasses and Grass Seed.
VII. Cost Keeping and Analysis.
VIII. Individual Problem.
IX. Fundamentals of Landscape Arrangement.
X. Drainage.

Practical and Scientific Course for Florists. — A special program for men and ımen engaged in floricultural work with a complete group of classes.

Courses Offered.

I. Soils and Fertilizers.
II. Garden Flowers and Bedding Plants.
III. Commercial Floriculture.
IV. Floral Arrangement.
V. Insect Pests.
VI. Plant Diseases.
VII. Special lectures by commercial florists, retail florists, and gardeners of note.

This Florists School is given only on alternate years and is scheduled next for ıuary to March, 1928.

Courses in Dairying. — A series of three ten-day courses in dairying are concted each year running in sequence from January through February.

Course I. Testing, Analyzing and Inspecting Dairy Products.
Course II. Milk Plant and Creamery Operation.
Course III. Ice Cream Making.

C. THE SUMMER SCHOOL.

The Summer School has been maintained by the college for a number of years. e experience of these years has been of value in arranging short, intensive, ctical courses that will meet the needs of teachers, home makers and prosional workers who wish instruction in agriculture, horticulture, education, l home economics, and who can most conveniently come to the college during summer. The instruction is given by the regular members of the college staff, isted by outside lecturers. The term period is six weeks.

College credit is now offered for work in the Summer School. For teachers l other students interested in professional improvement, or working for degrees, s change is especially valuable.

While agricultural courses were not presented during the past summer, if a nand develops for such work, it will be included in the program.

The nature of the work of the Summer School is indicated by the following ical program:

Home Economics:
- Garment making, elementary
- Dress design and construction, advanced
- Millinery
- Textiles
- Health education
- Foods

Science and Allied Courses:
- Dramatic presentation
- Design and practical arts
- Hygiene and sanitation
- General science
- Public health
- Food preservation
- Flower growing
- Botany for the teacher
- Cultivated trees and shrubs

Freshman and College Preparatory Courses:
- Plane geometry
- Higher algebra

Freshman and College Preparatory Courses — *Con.*
- Preparatory algebra
- Preparatory English
- College entrance English

Education and Allied Subjects:
- Principles and methods of teaching
- Special methods in vocational agricultural teaching
- Professional improvement problems
- Supervision and administration of agricultural education
- Vocational education
- Educational psychology
- Mental tests
- Content and methods in general science
- Methods of teaching English in the high school
- Method of teaching and supervision of mathematics
- Principles of secondary education
- Modern philosophy of education

D. ONE-YEAR VOCATIONAL POULTRY COURSE.

Purpose. — This course is designed for graduates of the agricultural vocational schools and others who wish to prepare themselves for practical poultry keeping, and can spend only one year at college.

Scope. — The work covers seven detailed courses in poultry husbandry as well as short-course work in fruit growing, market gardening, animal husbandry, or other subjects that will be helpful to poultry raisers. In addition to classroom and laboratory exercises each student is required to put in from eight to ten hours per week at the plant in the care and management of poultry, for the purpose of becoming proficient in the various branches of the work.

Entrance Requirements. — Applicants must be at least eighteen years of age and have a good elementary education.

Fees. — There is a tuition fee for residents of Massachusetts of $20 per term and a laboratory fee of $5 is required for both the fall and spring terms.

Note. — The course is limited to sixteen students. The One-Year Poultry Course begins at the beginning of the winter term and continues until the following December.

General Information.

A. FINANCIAL AND ADMINISTRATIVE.

Student Expenses.

Tuition. — Tuition for residents of Massachusetts is $60.00 per year. For udents who are not residents of Massachusetts, the tuition fee is $180 per year. udents entering from Massachusetts are required to file with the Treasurer a atement signed by either town or city clerk stating that the applicant's father a legal resident of Massachusetts.

All students entering the college for the first time as undergraduates or two-ar students are charged a matriculation fee of $5.00, which in the event of a ident's leaving the institution, is returned, if all bills due the college are paid, is upon graduation considered as payment for the diploma.

Rooms. — Students are expected, as far as possible, to occupy rooms in the llege dormitories. Students who do not live in the college dormitories must cure rooms approved by the college. The assignment of rooms, and the general pervision of the housing of students, is in charge of the Dean. At the end of ch college year all unoccupied rooms will be thrown open for selection, and will assigned to students according to classes.

Dormitory accommodations for men are available at the college for about 62 idents. Students desiring rooms in the dormitories, should make application the Dean of the college on or before the first Monday in May, and the Dean l give notice of the time and place for the assignment of rooms. A freshman nnot be assigned to a room in the dormitories until his entrance record has been cepted by the Dean. No assignment of rooms is made except through the regular plication blank, a copy of which can be obtained from the Dean. A deposit $5.00 is required when the reservation is made. The rental is $12.00 to $23.00 term.

Students who leave college at the end of the college year or who change from e room to another or from a college room to a private house or a society house st remove all furniture and property from their rooms immediately after com-ncement in June. Furniture not thus removed by the owner will be removed the college and stored at the owner's expense. The college will assume no ponsibility for any damage to the furniture thus stored. The rooms in the lege dormitories are unfurnished; for the most part, they are arranged in suites three, — one study room and two bedrooms. These rooms are heated by steam l lighted by electricity; they are cared for by students occupying them.

Dormitory accommodations for women are available at the college for 105 s. Applications for rooms should be made to the Advisor of Women. A hman cannot be assigned to a room in the dormitory until her entrance record been accepted by the Dean. A deposit of $5.00 is required when a room is erved. The rental is $33.00 to $39.00 per term. All students living in the igail Adams House take their meals at Draper Hall. Rooms in the dormitory furnished except for necessary bedding and linen. They are cared for by the dents occupying them.

Board. — All freshmen are required to board at the college dining hall. All nen students living in college dormitories are required to board at the dining ll.

The cost is $255.00 for the college year payable as follows: at the opening of college $78.00; December 1, $65.00; February 1, $60.00; April 1, $52.00.

Rebates at the rate of $6.00 per week may be granted for absences in excess of one week. No rebates will be allowed for absences of less than one week nor unless the absence is authorized by the Dean and the rebate approved by the Treasurer.

Laboratory Fees.

The principles observed in establishing laboratory fees are the requirement that students pay for those materials actually used which cannot be supplied by the individual, and that the laboratory fees include a charge sufficient to guard against wanton waste and breakage. Fees may be established for any course without previous announcement. At present, the fees charged are as follows:

	Per Term.
Agronomy:	
Course 25	$2 25
Course 27	2 25
Course 50	2 50
Course 51	2 50
Course 75	2 25
Course 77	2 50
Animal husbandry:	
Course 25	1 50
Course 26	1 50
Course 75	1 50
Dairying:	
Course 50	3 00
Course 51	3 00
Course 52	3 00
Course 75	3 00
Course 76	3 00
Course 77	3 00
Course 78	3 00
Farm Management:	
Course 51	50
Poultry Husbandry:	
Course 51	2 50
Course 52	3 00
Course 76	2 00
Course 77	2 00
Agricultural Engineering:	
Course 27	1 00
Course 30	1 50
Course 53	1 00
Course 55	1 00
Course 75	1 00
Course 78	1 00
Floriculture:	
Course 50	1 50
Course 51	1 50
Course 52	5 00
Course 53	1 00

	Per Term.
Floriculture — *Concluded*	
Course 55	$1 [illegible]0
Course 75	2 [illegible]0
Course 76	2 [illegible]0
Course 77	2 [illegible]0
Forestry:	
Course 55	1 [illegible]0
Course 57	1 [illegible]0
Course 58	1 [illegible]0
Landscape Gardening:	
Course 30	2 [illegible]0
Course 50	2 [illegible]0
Course 51	2 [illegible]0
Course 52	2 [illegible]0
Course 76	3 [illegible]0
Course 77	3 [illegible]0
Course 80	3 [illegible]0
Course 81	3 [illegible]0
Course 82	3 [illegible]0
Pomology:	
Course 54	4 [illegible]0
Course 75	4 [illegible]0
Vegetable Gardening:	
Course 50	2 [illegible]0
Course 52	2 [illegible]0
Course 53	2 [illegible]0
Course 75	3 [illegible]0
Course 76	2 [illegible]0
Drawing:	
Course 25	3 [illegible]0
Course 26	3 [illegible]0
Course 27	3 [illegible]0
Botany:	
Course 3	1 [illegible]0
Course 25	1 [illegible]0
Course 26	1 [illegible]0
Course 50	2 [illegible]0
Course 51	2 [illegible]0
Course 52	2 [illegible]0
Course 53	2 [illegible]0

otany — *Concluded*

	Per Term.
Course 54	$2 00
Course 55	3 00
Course 58	1 50
Course 59	1 50
Course 60	1 50
Course 61	1 50
Course 62	1 50
Course 63	1 50
Course 75	3 00
Course 76	3 00
Course 77	3 00
Course 78	3 00
Course 79	3 00
Course 80	3 00

hemistry:

Course 1	3 00
Course 2	3 00
Course 4	3 00
Course 5	3 00
Course 25	4 00
Course 26	4 00
Course 30	3 00
Course 51	5 00
Course 52	5 00
Course 53	5 00
Course 61	5 00
Course 62	5 00
Course 63	5 00
Course 75	5 00
Course 80	4 00
Course 81	5 00
Course 90	5 00
Course 91	5 00
Course 92	5 00
Course 93	5 00
Course 94	5 00
Course 95	5 00
Course 96	5 00
Course 97	5 00

ıtomology:

Course 50	1 00
Course 51	1 00
Course 53	1 00
Course 55	1 00
Course 75	2 00
Course 76	3 00
Course 77	1 00
Course 78	3 00

Mathematics and Engineering:

	Per Term.
Course 27	$1 50
Course 78	1 50

Microbiology:

Course 30	5 00
Course 50	5 00
Course 51	5 00
Course 52	5 00
Course 75	5 00
Course 76	5 00
Course 80	5 00
Course 81	5 00
Course 82	5 00
Course 83	5 00

Physics:

Course 25	3 00
Course 26	3 00
Course 27	3 00
Course 50	3 00
Course 51	3 00
Course 52	3 00

Veterinary Science:

Course 78	2 00
Course 79	2 00
Course 80	2 00
Course 85	2 00
Course 86	2 00
Course 87	2 00

Zoölogy:

Course 26	3 00
Course 50	3 00
Course 51	3 00
Course 52	3 00
Course 53	4 00
Course 75	3 00
Course 76	3 00
Course 77	3 00
Course 79	2 00

Music (each course)	3 00

Rural Home Life:

Course 28	1 50
Course 29	1 50
Course 32	1 50
Course 50	4 00
Course 51	4 00
Course 52	2 00
Course 61	1 50

Initial Charges.

At the opening of the college year, before students are registered in their classes, the following charges are payable at the treasurer's office:

	Freshmen.	Sophomores.	Juniors and Seniors.
Tuition (one term)	$20 00	$20 00	$20 00
Matriculation fee	5 00	–	–
Board (if at college dining hall) to Dec. 1	78 00	78 00	78 00
Room rent (if in college dormitory)	12 00–20 00	12 00–20 00	12 00–20 00
Laboratory fees	5 00	5 00	2 00–10 00
Military uniform deposit	19 50	19 50	–
Assessment for support of Social Union	1 50	1 50	1 50
Student tax for support of athletics [1]	5 00	5 00	5 00
Student tax for support of academic activities [1]	3 00	3 00	3 00
Other student activities, taxes [1]	50	50	50

[1] While this is not essentially a college charge, the treasurer of the college acts as collector for the student activity, and all students are expected to make the payment as indicated. The subscription price of the "Collegian" is fixed by the managers; the amount of athletic tax by vote of the student body.

Summary of Expenses for Year.

Tuition: citizens of Massachusetts, $60; others, $180 per year.

	Low.	High.
Tuition (citizens of Mass.)	$60 00	$60 00
Matriculation fee (first year)	5 00	[illegible]00
Room in college dormitories or in private houses	39 00	14[illegible]00
Board, $8 per week (College Dining Hall)	255 00	25[illegible]00
Laundry, 50 to 85 cents a week	18 00	3[illegible]00
Laboratory fees	8 00	2[illegible]00
Books, stationery and miscellaneous items	40 00	6[illegible]00
	$425 00	$57[illegible]00

Other Expenses. — Prospective students should understand that the above estimates cover expenses which may be called strictly college expenses, and that there are other financial obligations voluntarily placed upon students which they should expect to meet. Chief among these are class assessments and taxes levied for maintenance of various organizations, such as the Social Union, Athletic Association, weekly publications, etc. Such expenses vary from $15 to $30 a year. Additional financial responsibility is also assumed by students joining a fraternity or entering into other social activities of the college. Students rooming in college dormitories are obliged to equip their own rooms with furniture. The college assumes no responsibility in regard to the safe-keeping of student property either during the college term or vacations, except under such special arrangements as may be made with the treasurer. Besides the amount necessary for clothes and traveling, the economical student will probably spend between $500 and $[illegible]0 per year.

Student Accounts.

The following rules are enforced concerning student accounts:

No student will be allowed to graduate until all bills due the institution from him are paid.

College charges, such as room rent, laboratory fees and tuition, must be paid in advance, at the beginning of each term. This rule is strictly adhered to, and no student will be allowed to complete his registration until such payments are made.

Every student boarding at Draper Hall is required to pay at the beginning of each term at least one month's board in advance; and no student will be allowed to continue to board at Draper Hall if at any time during the term he is more than one week in arrears in his payment for board.

All money due for student labor shall at the discretion of the treasurer of the college be applied on account toward any bills that a student may owe to the institution.

Student Aid.

SELF-HELP. — Many students are obliged to find work of some sort to earn their y through college. A few men have met their entire expenses in this manner, ny more have paid a large part of their expenses, and many have earned a all proportion of the cost of their college education; but the college recommends at no new student enter without having at least $300 and preferably $400 with ich to pay his way until he can establish himself in some regular work. The lege does not encourage students to enter without money in the expectation of ning their way entirely. The ordinary student will find it better to work and umulate money before coming to college, or to take more than four years completing his college course, or, instead, to borrow money sufficient to carry n through. No student should undertake work that interferes with his studies, d students should understand that, owing to the large number of applications employment, no one man can receive a large amount of work at the college. number of students find opportunities for earning money without depending on the college to furnish them with work.

So far as possible needy students will be employed in some department of the lege. The divisions of agriculture and horticulture usually afford the most rk, although there are several permanent janitorships available for students, l forty or more students are employed at the dining hall.

Application for student labor should be made directly to Robert D. Hawley, retary of the college. Students whose deportment or class work is not satistory are not likely to be continued in student labor. The most desirable and ponsible positions are naturally assigned to those needy students who have n in the institution longest and who have demonstrated their need and ability. dents, therefore, may find it rather difficult to obtain all the work they desire ing their freshman year.

SPECIAL NOTICE TO NEEDY STUDENTS. — In the last few years the demand for d labor on the part of new students has far exceeded the amount of employnt that the college can offer. The college cannot promise work to any student, ticularly to freshmen; it accordingly urges prospective students who are dedent entirely upon their own efforts not to undertake the course before they e earned enough money to carry them through, or nearly through, the first r.

Scholarships.

THE WARD FUND.

The so-called Ward Fund is available for the assistance of needy boys from npshire County attending the Massachusetts Agricultural College. This fund lministered by a Board of Trustees not connected with the College. Application nks for assistance from this fund may be secured from the Treasurer of the lege.

THE FREDERICK G. CRANE FUND.

The family of the late Frederick G. Crane of Dalton has presented to the Massachusetts Agricultural College a gift of $25,000 to establish a fund in memory of Frederick G. Crane, the income therefrom to be expended by the Trustees in aid of worthy undergraduate four-year students of limited financial resources attending the College, preference being given to residents of Berkshire County. Grants made from this fund are to be known as Frederick G. Crane Scholarships.

Applications.

All applications for loans or gifts from this fund should be made to the President, Massachusetts Agricultural College, Amherst, Mass., under whose direction an investigation will be made of the merits of the applicants. The purpose of this investigation will be to insure that the aid is extended to students whose parents are in such financial condition that assistance is necessary in order to insure a college education for the applicants; that it is extended only to students who propose to complete their college education at the Massachusetts Agricultural College; and that it is given to those whose character and scholarship record justifies the assistance available through this fund.

Aid to Freshmen.

Grants from the Crane Fund will be made to freshmen in the form of loans supported by notes bearing indorsements satisfactory to the President of the College. These notes will bear interest and will be negotiable. The College, however, will at its discretion cancel these notes at the end of one year if the scholarship record of the student, his character, and his plans for the future appear to the President so to warrant.

Aid to Sophomores.

Grants will be made to sophomores either on the plan outlined for freshmen as given above or on the plan outlined for juniors and seniors as given below.

Aid to Juniors and Seniors.

Grants to juniors and seniors will usually be in the form of gifts and will be awarded with consideration of the need, of the scholarship, and of the character of the applicant.

Amount of Grants.

The amount of grants from this fund, made either as loans or as gifts, will be determined by the need of the applicant and by the amount of money available in the fund. Generally one may expect to receive from $50 to $150 per year.

Memorial Hall.

Soon after the close of the World War the alumni, students, faculty and friends of the college subscribed $150,000 for the erection of a soldier memorial building to be placed on the college campus. This building was completed in the summer of 1921. It is designed to serve as headquarters for the student activities, and as the center of the social life of the institution.

In the basement are bowling alleys, pool tables, a store, post office and barber shop. On the main floor are eight offices for leaders of various student activities, a large reading room, and a beautiful memorial room in which is found the tablet bearing the names of the sons of the college who gave their lives in the great war. On the second floor is an auditorium seating 350 persons. This room is also used for college dances.

Honor Council.

All tests and examinations are conducted under the honor system, which is administered by an Honor Council chosen by the students. Recommendations for discipline are made to the President of the college by the Honor Council.

Student Relations.

The customary high standard of college men in honor, manliness, self-respect and consideration for the rights of others constitutes the standards of student deportment.

The privileges of the college may be withdrawn from any student at any time if such action is deemed advisable.

It should be understood that the college, acting through its president or any administrative officer designated by him, distinctly reserves the right, not only to suspend or dismiss students, but also to name conditions under which students may remain in the institution. For example, if a student is not doing creditable work he may not only be disciplined but he may also be required to meet certain prescribed conditions in respect to his studies, even though under the foregoing rules his status as a student be not affected. The same provision applies equally the matter of absences ("cuts"). According to the rules a student is allowed a ·tain percentage of absences from class and other exercises. This permission, ıich implies a privilege and not a right, may be withdrawn at any time for any ıse.

Similarly, also, it applies to participation in student activities. Though this will linarily be governed by the rules as already laid down, yet, if in the judgment the college authorities, a student is neglecting his work on account of these ;ivities, the privilege of participating in them may be withdrawn for such time is considered necessary. Moreover, it may be withdrawn as a punishment for sconduct. Prospective students or their parents may, upon application, obtain opy of the faculty rules governing student relations to the college.

Infirmary.

The college maintains an infirmary for the care of sick or injured students.

Two small buildings, built especially for hospital purposes, are used for the ırmary.

The following statement outlines the plan followed in the management of the ırmary with respect to students: —

Management of the Infirmary.

Supervision.

.. The infirmary is under the *general supervision* of Prof. Charles E. Marshall, o is designated as Supervisor of the Infirmary. A resident nurse is in *immediate* ırge of the infirmary.

Use of Infirmary.

!. Students are urged to go to the infirmary at any time that they are in need ;he services rendered by the resident nurse or by a town physician. Inasmuch the physical director gives special attention to all student diseases, it is to be ›ected that the majority of the students will go to the infirmary at his sugges- ı. This understanding, however, should in no way deter students from going the infirmary voluntarily at any time.

General Health.

. Students are urged to consult the physical director or the resident nurse im- liately when signs of physical disorder appear. Severe attacks of cold or er forms of illness can usually be avoided if treatment is administered in the pient stage. The purpose of the infirmary is to help maintain the general good lth of the students, as well as to furnish a suitable place for professional atten- ı in cases of severe illness or accident.

General Fee.

. The infirmary fee will be at the rate of $2 a day, and will be charged when or more meals are obtained at the infirmary, or when the student remains at infirmary for one or more nights. A nominal charge will be made to out- ients for miscellaneous treatment of a minor character.

Additional Expenses.

! In addition to the fee charged, as specified in paragraph 4, the following addi- al expenses will be charged to the patient: —

ı) *Nurses.* — In case a special nurse is required for the proper care of an in- dual, the services and board of this nurse will be paid by the patient. Such a ıe will be under the general supervision of the resident nurse.

›) *Professional Service.* — If a student requires medical attention by a physi- , he will be required to select his physician and become responsible for fees ·ged by the physician.

(c) *Supplies.* — Special medical supplies prescribed by a physician or nurse will be charged to the patient.

(d) *Laundry.* — Expense for personal laundry incurred by students while in the infirmary will be charged to the individual student.

B. COLLEGE ACTIVITIES.

General Exercises.

Chapel exercises are held two mornings each week. On Thursdays during the fall term, and on Wednesdays during the winter and spring terms, an afternoon assembly is held, to which some prominent layman or professional man is invited to speak. The object of these assemblies is to bring to the students discussion of topics of present-day interest. A special chapel service on Sunday is held during the winter months. Students are required to attend these general exercises, although the president is authorized to excuse from chapel any student who may object to attendance thereon because of his religious scruples, provided his request for excuse therefrom is endorsed by his parent or guardian.

Student Activities.

A large number of student organizations furnish opportunity to students for work and leadership.

The Massachusetts Agricultural College Social Union was established in 1907. All students become members of the union by paying a small fee. In the fall and winter months the union gives a series of entertainments, free to students and faculty.

The College Senate is composed of representatives of the junior and senior classes. This body serves as a general director of undergraduate conduct, and represents before the faculty the interests of the student body.

The Young Men's Christian Association and the Young Women's Christian Association are active both socially and religiously.

Intercollegiate and intermural athletic contests are held throughout the year in the leading sports, including football, baseball, track, hockey and basketball. The athletic board, composed of alumni, faculty and students, has charge of finances, schedules, and general policies governing athletics.

The musical clubs include an orchestra, a glee club and a girls' glee club. These give a number of concerts, usually followed by dancing, during the year, both in Amherst and on tour. A dramatic club, The Roister Doisters, presents annually a revue and two plays, one in connection with the promenade and the other at commencement. There are, besides the declamation and oratorical prize contests, both class and intercollegiate debates.

The college publications are the "Massachusetts Collegian," the weekly newspaper; "The Index," the year book; and "The Alumni Bulletin," issued from the office of the alumni secretary. Judging teams under the direction of the departments of Animal Husbandry, Poultry Husbandry, Pomology and Floriculture compete with teams from other agricultural colleges. The Academic Activities Board, composed of alumni, faculty and students, has charge of the finances, schedules, etc., of the various clubs and publications.

Commencement.

Commencement exercises are directed by a committee composed of faculty, alumni and student representatives. The program includes a day devoted to undergraduate activities, an alumni day, Baccalaureate Sunday and Class Day. The second Sunday in June is fixed as the central date for commencement. The program for 1926 follows:

Friday, June 11: Undergraduate Day.
2–30 P.M. Freshman-Sophomore Baseball Game.
8–00 P.M. Flint Oratorical Contest, Memorial Hall.

Saturday, June 12: Alumni Day.

8–30 A.M.	Baseball Game — Odds *v.* Evens.
10–00 A.M.	Alumni Meeting, Memorial Hall.
12–00 M.	Alumni Dinner, Draper Hall.
1–30 P.M.	Band Concert and Alumni Addresses.
3–00 P.M.	Alumni Parade.
3–30 P.M.	Varsity Baseball Game, M. A. C. *v.* Amherst College.
6–00 P.M.	Fraternity Reunions.
8–30 P.M.	Dramatics, Bowker Auditorium.

Sunday, June 13: Baccalaureate Sunday.

9–00 A.M.	Academics and Varsity Clubs Meetings. 1916–Faculty Breakfast.
3–30 P.M.	Baccalaureate Address, Bowker Auditorium.
5–00 P.M.	President's Reception, Rhododendron Garden.

Monday, June 14: Class Day.

9–00 A.M.	Cavalry Drill.
10–30 A.M.	Senior Class Day Exercises.
2–00 P.M.	Commencement Exercises, Bowker Auditorium.
8–30 P.M.	Sophomore-Senior Hop, Memorial Hall.

Alumni class reunions held by individual class arrangement.

C. ACADEMIC AND DEPARTMENTAL.

Degrees.

Those who complete the four-year course receive the degree of bachelor of science. e fee for graduation from the college is $5.

Graduate students who complete the assigned courses will receive the degree of ster of science upon the payment of a fee of $10. Credit may sometimes be owed towards this degree for teaching or other advanced work done in some de- tment of the college.

Graduate students who complete the required three-year course of study, and sent a satisfactory thesis, will be granted the degree of doctor of philosophy. e diploma fee in this instance is $25.

Those to whom degrees are awarded must present themselves in person at com- ncement to receive them. No honorary degrees are conferred.

The honorary fraternity of Phi Kappa Phi has a chapter at the college. Students elected to membership to this fraternity on the basis of scholarship. Elections made from the highest tenth of the senior class who have attained an average de of at least 85 per cent during their college course.

Prizes and Awards, 1926.

Prizes and awards are offered annually in several departments for excellence tudy or for other special achievements. Awards in 1926 were:

Phi Kappa Phi Elections. — Those members of the senior class whose scholar- average has been 85% or above are eligible for election to the honorary Society Phi Kappa Phi, not more than 10% of the class, however, being elected; elections n the class of 1926 were:

Elmer Everett Barber.	Alvah Wesley Jones.
Maude Elinor Bosworth.	Lawrence Lakin Jones.
Mary Turck Boyd.	Majel Margaret MacMasters.
Ernest Albert Dick.	Henry Howe Richardson.
Alton Herman Gustafson.	Margaret Park Smith.

Grinnell Prizes. — The Grinnell prizes, given by the Hon. William Claflin of Boston in honor of George B. Grinnell, Esq., of New York, for excellence in theoretical and practical agriculture. The contest is open to those senior students se record on the registrar's books shows an average standing of 80 or above

for the technical work taken in the Divisions of Agriculture and Horticultu
during the junior and senior years.

First Prize, $25, Preston Julian Davenport.

Second Prize, $15, Donald Reed Williams.

Third Prize, $10, Albert Irving Mann.

Hills Botanical Prizes. — The Hills Botanical Prizes, given by the la Henry F. Hills of Amherst for the best and second best herbaria. Competitic is open to members of the senior, junior, and sophomore classes.

First Prize, $20, Frances Clarinda Thompson, 1928.

Burnham Prizes. — The Burnham prizes, awarded to the students deliverir the best and second best declamations in the Burnham contest. The prelimina contests in declamation are open, under certain restrictions, to freshmen, ar sophomores.

No awards in 1926.

Flint Prizes. — The Flint prize, awarded to the students delivering the be orations.

First Prize, $30, Eliot Perkins Dodge, 1926.

Second Prize, $15, Ralph Warner Haskins, 1927.

The Massachusetts Society for the Promotion of Agriculture. — T Massachusetts Society for the Promotion of Agriculture provided for 1926–19 two prizes of $300 each to be awarded to members of the class of 1927 for excellen in scholarship and two prizes of $200 each to members of the class of 1928 who a majoring in the Divisions of Agriculture or Horticulture. Prizes of $300: Claren Howard Parsons, 1927, and Calton Oliver Cartwright, 1927. Prizes of $20 Paul Frederick Frese, 1928 and Gordon Everett Bearse, 1928.

Allan Leon Pond Memorial Medal, for Excellence in Football. — T Allan Leon Pond Memorial Medal for general excellence in football in memo of Allan Leon Pond of the Class of 1920 who died February 26, 1920. In 19 this medal was awarded to Alton Herman Gustafson, 1926.

Southern Alumni Baseball Cup. — The Southern Alumni Baseball C awarded to the member of the baseball team who contributed most to the succe and reputation of the team, both in respect to skill and spirit. In 1926 this mec was awarded to John Burrington Temple, 1926.

Academics Conspicuous Service Trophy. — The Academics Conspicuc Service Trophy awarded to the student who during the previous twelve mont has made the most important single contribution to the academic activities. 1926, awarded to Theodore James Grant of the Class of 1926.

Eldred Memorial Prize. — A prize established in honor of Frederick C nelius Eldred, of the Class of 1873, famous oarsman and pioneer in athletics M. A. C., who trained, coached and stroked crews in four intercollegiate races two to victory. This prize of one hundred dollars may be awarded at Commen ment to that member of the senior class who has represented the college in int collegiate athletic contests for a period of not less than two years, and who h attained the highest average standing in scholarship during his course.

Philip Henry Couhig of the Class of 1926 was awarded $50 in 1926 from t fund. This award was made upon the basis of the most constructive suggesti presented in written form for the physical development of the student body wi particular reference to that portion which does not participate in major sports.

Degrees Conferred — 1926.

Doctor of Philosophy (Ph.D.).

ınborn, Joseph Raymond, B.Sc., Massachusetts Agricultural College	North Amherst.

Master of Science (M.Sc.).

artlett, Frederick Sheldon, B.Sc., Massachusetts Agricultural College	Westfield.
upery, Martin E., A.B., Hope College	Friesland, Wis.
oley, Mary Joan, B.Sc., Massachusetts Agricultural College	Amherst.
arabedian, Hovanes, B.A., International College, Smyrna	Smyrna, Asia Minor.
illigan, Gerald Matthew, B.Sc., Massachusetts Agricultural College	Amherst.
acroix, Donald Sewall, B.Sc., Massachusetts Agricultural College	Amherst.
anphear, Marshall Olin, B.Sc., Massachusetts Agricultural College	Amherst.
ercival, Gordon Pittinger, B.Sc., Massachusetts Agricultural College	Medfield.

Bachelor of Science (B.Sc.).

aker, Francis Everett	Hopkinton.
aker, Frederic Allen	Springfield.
arber, Elmer Everett	Jamaica Plain.
artlett, Herbert Franklin	West Springfield.
enoit, Helen Anna	Amherst.
lock, Harry William	Maplewood.
orgeson, Melvin Benjamin	Auburn.
osworth, Marguerite Rose	Holyoke.
osworth, Maude Elinor	Holyoke.
ower, James, Jr.	Holyoke.
oyd, Mary Turck	Ortega, Fla.
udge, William Karl	Mattapan.
urt, Stanley Lyman	Easthampton.
assidy, Marion Stewart	Wellesley.
ormier, Francis Joseph	Newtonville.
ouhig, Philip Henry	Beverly.
oveney, John Joseph	Amherst.
avis, Evelyn Louise	Springfield.
eVito, Dominick	Roxbury.
ick, Ernest Albert	Lawrence.
odge, Eliot Perkins	Beverly.
oolittle, Alden Hartwell	Northfield.
ouglass, Earle Lawrence	Springfield.
ow, Philip Norman	Bolton.
urkee, Lewis Leland	Beverly.
essenden, Richard William	Middleborough.
tzgerald, Lillian Alice	Holyoke.
ynn, Alan Foster	Newton.
ord, William Warner	Dalton.
raser, Carl Arthur	Westborough.
raser, Harry Edward	Jamaica Plain.
albraith, Leo Lake	South Hadley.
avin, Linus Arthur	Natick.
oodwin, Marvin Warren	Reading.
oren, Louis	Chelsea.
rant, Theodore James	Auburndale.
rayson, Herbert	Milford.
ustafson, Alton Herman	Campello.
aynes, Walter Lincoln	Springfield.
ill, Arthur Blair	Walpole.
ollingworth, Duncalf Wright	Providence, R. I.
owes, Stanley Edward	Brimfield.
uke, Barbara Allen	South Hadley Falls.
graham, Edward Forster	Millis.
meson, Matthew	Everett.
nsen, Harold Stery	Westfield.
hnson, Philip	Amherst.
nes, Alvah Wesley	Salisbury.
nes, Lawrence Lakin	Campello.
afafian, Sarkis Petros	Amherst.
elso, George	Reading.
mbert, John Ford	Gleasondale.
ngshaw, Hatton, Jr.	New Bedford.
ursinos, George John	Westfield.

Loud, Emery Shaw	North Abington.
MacMasters, Majel Margaret	Ashburnham.
Mann, Albert Irving	Dalton.
Moberg, Herbert Elof	Brockton.
Moran, John	Amherst.
Needham, Basil Arthur	Taunton.
Nichols, Chester Willard	Natick.
Nichols, Helen Louise	Northampton.
Nickerson, Elsie Elizabeth	East Boston.
Norcross, Roy Ellis	Brimfield.
Novick, Leo Altshuler	Amherst.
Otto, Raymond Herman	Lawrence.
Palmer, Cary Davis	Grafton, Vt.
Pomeroy, Elisabeth Clark	Longmeadow.
Potter, Royal Wesley	Providence, R. I.
Putnam, Ruth Evelyn	Greenfield.
Reed, Charles Porter	West Bridgewater.
Richards, James Marsh	Springfield.
Richardson, Henry Howe	Millis.
Rowen, Edward Joseph	Westfield.
Sawyer, Roland Darrow, Jr.	Ware.
Shea, Margaret Catherine	Holyoke.
Smiley, Ray Guild	Worcester.
Smith, Margaret Park	Taunton.
Smith, Myron Newton	Millbury.
Smith, Raymond Ellingwood	Salem.
Sniffen, Loren Fillow	Westport, Conn.
Spooner, Raymond Hildreth	Brimfield.
Stevens, Alvin Gay	Needham.
Stopford, William Turner	Newtonville.
Sullivan, Charles Noyes	Fall River.
Sullivan, Donald Clifford	Amherst.
Sweetland, Augustus Francis	Stoneham.
Temple, John Burrington	Shelburne Falls.
Tetreault, Albert Joseph	New Bedford.
Thompson, Gerald Thayer	Shelburne Falls.
Thurlow, George Harold	West Newbury.
Tucker, Edwin Locke	Baldwinsville.
Tulenko, John	Sunderland.
Turner, Charles Edgar	Springfield.
VanAlstyne, Lewis Morrell	Kinderhook, N. Y.
Warren, Francis Walter	Stow.
Wheeler, Ellsworth Haines	Bolton.
White, Earl Martin	Abington.
White, Montague	West Hartford, Conn.
Williams, Donald Reed	Northfield.
Wilson, James Stewart	Brooklyn, N. Y.
Yarwood, George Arthur	Syracuse, N. Y.

Bachelor of Vocational Agriculture (B.Voc.Agri.).

Davenport, Preston Julian	Shelburne Falls.

Registration, 1926–27.

As of November 1, 1926.

Graduate Students.

ꟷrchibald, John G.	North Amherst.
B.S.A., Ontario Agricultural College.	
M.Sc., Massachusetts Agricultural College.	
ꟷrrington, Luther B.	Florence.
B.Sc., Massachusetts Agricultural College.	
Barber, Elmer E.	Jamaica Plain.
B.Sc., Massachusetts Agricultural College.	
Chesley, George L.	Concord, N. H.
B. Humanics, Springfield Y. M. C. A. College.	
Cossmann, Paul A.	Lunenburg, Nova Scotia, Can.
B.S.A., Macdonald College.	
Couhig, Philip H.	Beverly.
B.Sc., Massachusetts Agricultural College.	
Drain, Brooks D.	Amherst.
B.Sc., Ohio State University.	
M.Sc., University of Chicago.	
Dull, Malcolm	Muskegon, Mich.
A.B., Hope College.	
Fessenden, Richard W.	Middleborough.
B.Sc., Massachusetts Agricultural College.	
Foley, Mary J.	Amherst.
B.Sc., M.Sc., Massachusetts Agricultural College.	
France, Ralph L.	Wilmington, Del.
B.Sc., University of Delaware.	
Fuller, James E.	Amherst.
A.B., A.M., Colorado College.	
Garvey, Mary E. M.	Amherst.
B.Sc., Massachusetts Agricultural College.	
Gates, Clifford O.	Kokomo, Ind.
B.S.A., Purdue University.	
Gavin, Linus A.	Natick.
B.Sc., Massachusetts Agricultural College.	
Goodwin, William I.	North Amherst.
B.Sc., Massachusetts Agricultural College.	
Hallowell, Elizabeth	Wollaston.
A.B., A.M., Boston University.	
Hamilton, W. Brooks	St. Lambert, Que., Can.
B.S.A., Macdonald College.	
Hawley, Henry C.	Amherst.
A.B., Oberlin College.	
M.B.A., Harvard Graduate School of Business Administration.	
Johnson, Loyal R.	Monte Vista, Col.
B.Sc., Colorado Agricultural College.	
Kelly, Oliver W.	Amherst.
B.Sc., Colorado Agricultural College.	
Landry, Herbert A.	West Springfield.
B.M.E., School of Engineering, Northeastern University.	
Larsinos, George J.	Westfield.
B.Sc., Massachusetts Agricultural College.	
MacMasters, Majel M.	Collinsville, Conn.
B.Sc., Massachusetts Agricultural College.	
Muller, Richard T.	Amherst.
B.Sc., Cornell University.	
M.Sc., University of Maine.	
O'Brien, Mary C.	Greenfield.
B.Sc.Educ., Normal Art School.	
Roberts, Oliver C.	Amherst.
B.Sc., Massachusetts Agricultural College.	
Sagendorph, Richard S.	Spencer.
B.Sc., Dartmouth College.	
Salman, Kenneth A.	Needham.
B.Sc., Massachusetts Agricultural College.	
Sanctuary, William C.	Amherst.
B.Sc., Massachusetts Agricultural College.	
Sazama, Robert F.	Northampton.
B.Sc., Massachusetts Agricultural College.	

Scheffer, William J. . . . . Magyarovar, Hungary.
Dipl.Agric., Royal Hungarian Agri. Academy of Magyarovar.
Dipl.Agric., State College of Agriculture, Berlin.
Seymour, Frank C. . . . . North Amherst.
A.B., Harvard University.
B.D., Union Theological Seminary.
Small, Alan F. . . . . Worcester.
A.B., Bowdoin College.
Spooner, Raymond H. . . . . Brimfield.
B.Sc., Massachusetts Agricultural College.
Springs, James D. . . . . Merchantville, N. J.
B.A., Clark University.
Swanback, T. Robert . . . . North Amherst.
Agronom., Agricultural College of Ultuna, Sweden.
Van Meter, Ralph A. . . . . Amherst.
B.Sc., Ohio State University.
Wagner, Bertha M. . . . . Amherst.
B.S.S., Boston University.

Registered after the Catalogue for 1925 was published.

Barrows, William B. . . . . Amherst.
A.B., Columbia University.
M.F., Yale University, School of Forestry.
Bauer, John J. . . . . New Bedford.
Ph.B., Brown University.
Benoit, Helen A. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Brown, Paul W. . . . . Fiskdale.
B.Sc., Massachusetts Agricultural College.
Buchanan, Walter G. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Coveney, John . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Cowing, William A. . . . . West Springfield.
A.B., Colby College.
Drain, Brooks D. . . . . Amherst.
B.Sc., Ohio State University.
M.Sc., University of Chicago.
Flynn, Alan F. . . . . Newton.
B.Sc., Massachusetts Agricultural College.
Fuller, James E. . . . . Amherst.
A.B., A.M., Colorado College.
Goodwin, Hope C. . . . . North Amherst.
A.B., Brown University.
Goodwin, William I. . . . . North Amherst.
B.Sc., Massachusetts Agricultural College.
Halloran, Elizabeth A. . . . . Northampton.
A.B., Smith College.
Hamilton, W. Brooks . . . . St. Lambert, Que., Can.
B.S.A., Macdonald College of McGill University.
Hammill, Edgar E. . . . . Little Falls, N. J.
A.B., Amherst College.
Hemenway, Justin S. . . . . Williamsburg.
B.Sc., Massachusetts Agricultural College.
Jack, Melvin C. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Keller, Paul . . . . Boston.
B.Sc.Educ., Boston University.
Kelly, Leslie M. . . . . Amherst.
B.Sc.Educ., Bridgewater Normal School.
Lacroix, Donald S. . . . . East Wareham.
B.Sc., Massachusetts Agricultural College.
Landry, Herbert A. . . . . West Springfield.
B.M.E., School of Engineering, Northeastern University.
Larkin, Clarence J. . . . . Haydenville.
B.A., Amherst College.
Levine, Sophie . . . . Springfield.
Ph.G., Massachusetts College of Pharmacy.
Locke, Christine B. . . . . West Springfield.
A.B., Boston University.
Lynch, Joseph C. . . . . Taunton.
B.B.A., Boston University.
Muller, Richard T. . . . . Amherst.
B.Sc., Cornell University.
M.Sc., University of Maine.
O'Brien, Mary C. . . . . Greenfield.
B.Sc.Educ., Normal Art School.
O'Donnell, Mary E. . . . . Northampton.
A.B., Smith College.
Patch, Henry L. . . . . Wenham.
B.Sc., Massachusetts Agricultural College.
Pulley, Marion G. . . . . Melrose.
B.Sc., Massachusetts Agricultural College.
Rand, Lena Adams . . . . Wethersfield, Conn.
B.A., M.A., Wesleyan University.
Roberts, Oliver C. . . . . Amherst.
B.Sc., Massachusetts Agricultural College.
Rorstrom, Hans A. . . . . Northampton.
B.Sc., Massachusetts Agricultural College.

Rotunno, Noreda A. B.S.A., M.Sc., Syracuse University.	Syracuse, N. Y.
Salman, Kenneth A. B.Sc., Massachusetts Agricultural College.	Needham.
Sanborn, Ruby A.B., Mount Holyoke College.	Amherst.
Sanctuary, William C. B.Sc., Massachusetts Agricultural College.	Amherst.
Strong, Ruth A. A.B., Smith College.	Amherst.
Tower, Alfred L. B.Sc., Massachusetts Agricultural College.	Sheffield.
Tumey, Malcomb E. B.Sc., Massachusetts Agricultural College.	Deerfield.
Turner, Charles E. B.Sc., Massachusetts Agricultural College.	Springfield.
Woodbury, Samuel L. B.Sc., Massachusetts Agricultural College.	Springfield.

Graduate Students Enrolled in the Summer School.

Benoit, Helen A.	Amherst.
Buchanan, Walter G.	Amherst.
Coveney, John	Amherst.
Cowing, William A.	West Springfield.
Drain, Brooks D.	Amherst.
Flynn, Alan F.	Newton.
Fuller, James E.	Amherst.
Garvey, Mary E. M.	Amherst.
Goodwin, Hope C.	North Amherst.
Goodwin, William I.	North Amherst.
Halloran, Elizabeth A.	Northampton.
Hamilton, W. Brooks	St. Lambert, Que., Can.
Hemenway, Justin S.	Williamsburg.
Jack, Melvin C.	Amherst.
Kelly, Leslie M.	Amherst.
Kelly, Oliver W.	Amherst.
Linehan, Mary D.	Amherst.
McDonnell, Anna H.	Florence.
Mayo, William I., Jr.	Northampton.
O'Brien, Mary C.	Greenfield.
O'Donnell, Mary E.	Northampton.
Pulley, Marion G.	Melrose.
Rand, Lena Adams	Wethersfield, Conn.
Ross, Charles F.	Lee.
Rotunno, Noreda A.	Syracuse, N. Y.
Salman, Kenneth A.	Needham.
Strong, Ruth A.	Amherst.
Tower, Alfred L.	Sheffield.
Turner, Charles E.	Springfield.

Class of 1927.

Ames, Robert Call	Falmouth	46 Pleasant Street.
Amstein, William Gerald	South Deerfield	Q. T. V.
Anderson, Andrew Bremer	Hudson	Lambda Chi Alpha.
Baker, Philip Woodell	Amherst	165 S. Pleasant Street.
Barnes, Russell Norris	Wallingford, Conn.	Sigma Phi Epsilon.
Biron, Raphael Alfred	Amesbury	Theta Chi.
Black, Lewis Herbert	Williamsburg	Alpha Gamma Rho.
Boden, Frank Joseph	North Wilbraham	29 North Prospect Street.
Bovarnick, Max	Dorchester	14 South College.
Briggs, Lawrence Elliott	Rockland	Theta Chi.
Bruce, Frances Clara	Easthampton	Abigail Adams House.
Buckler, Ella Maude	Pittsfield	Abigail Adams House.
Burrell, Robert Wallace	Abington	Theta Chi.
Campbell, Donald Hays	Shirley	Lambda Chi Alpha.
Carlson, Oscar Ernest	Boston	Kappa Epsilon.
Cartwright, Calton Oliver [1]	Northampton	Kappa Epsilon.
Chamberlain, Alexander Rodger	Springfield	Lambda Chi Alpha.
Clagg, Charles Floyd	Barnstable	Alpha Gamma Rho.
Cobb, Roger Madison	Wrentham	15 Hallock Street.
Connell, Edward Anthony	Malden	Sigma Phi Epsilon.
Cook, Wendell Burnham	Townsend	West Experiment Station.
Crooks, Clarence Arthur	North Brookfield	Alpha Gamma Rho.
Cummings, Maurice Andrew	Cambridge	Theta Chi.
Cutler, Samuel	Springfield	14 South College.
Davison, Ruth Eugenia	West Springfield	Abigail Adams House.
Dole, William Levi	Medford	Kappa Sigma.
Farwell, Theodore Austin	Turners Falls	Alpha Sigma Phi.
Foley, Richard Carol	Portland, Me.	Sigma Phi Epsilon.
Galanie, Demetrius Lincoln	Natick	Alpha Sigma Phi.
Goldberg, Louis Noah	Wilmington	13 South College.
Goller, Hilda Margaret	Holyoke	Abigail Adams House.
Goodell, Ruth Edna	Westborough	Abigail Adams House.
Greenaway, James Emerson	Springfield	Lambda Chi Alpha.
Greenwood, Elliott Kelton	Hubbardston	Q. T. V.

[1] Candidate for degree B.Voc.Agri.

Griffin, Raymond George	Southwick	Sigma Phi Epsilon.
Haertl, Edwin Jacob	West Roxbury	Kappa Sigma.
Hanson, Daniel Cameron	Dracut	Alpha Gamma Rho.
Harris, Herbert Joseph	Springfield	The Apiary.
Hart, Ralph Norwood	Dorchester	Alpha Gamma Rho.
Haskins, Ralph Warner	Greenfield	Q. T. V.
Hatch, George Franklin, Jr.	West Roxbury	Theta Chi.
Hatch, Harold Curtis	Melrose	53 Lincoln Avenue.
Henneberry, Thomas Vincent	Manchester	Phi Sigma Kappa.
Huthsteiner, Elladora Kathryn	Pittsfield	Abigail Adams House.
Ingraham, Mary	Millis	Abigail Adams House.
Kane, Thomas Joseph	Westfield	Q. T. V.
Krassovsky, Lenoid Alexander	Russia	Kappa Gamma Phi.
Kuzmeski, John William	Leverett	Amherst, R. F. D.
LeNoir, Thomas Benjamin	Greenwood	Alpha Sigma Phi.
Mahoney, John Joseph	Westfield	Q. T. V.
Malley, Joseph Anthony	Watertown	3 North College.
Maxwell, Lewis Joseph	Stoneham	Kappa Gamma Phi.
McAllister, Robert Wright	North Billerica	Alpha Gamma Rho.
McCabe, Edith Mary	Holyoke	Abigail Adams House.
McVey, Ernest Gregory	North Easton	Q. T. V.
Merlini, Angelo Albert	North Adams	Sigma Phi Epsilon.
Milligan, Kenneth William	State Line	Lambda Chi Alpha.
Mullen, Francis Redding	Becket	Sigma Phi Epsilon.
Murdough, Edwin Lincoln	Springfield	Lambda Chi Alpha.
Nash, Norman Blake	Abington	Kappa Sigma.
Nottebaert, Harry Charles	Lexington	Lambda Chi Alpha.
Parkin, William Hildreth	Chicopee	Kappa Epsilon.
Parsons, Clarence Howard	Amherst	North Amherst.
Parsons, Josiah Waite, Jr.	Northampton	Kappa Sigma.
Partenheimer, Merrill Henry	Greenfield	Phi Sigma Kappa.
Peirce, Veasey	East Weymouth	Phi Sigma Kappa.
Pickens, Herman Eames	Stoneham	Kappa Gamma Phi.
Pyle, Everett John	Plymouth	Theta Chi.
Reed, James Burbank	Waltham	Theta Chi.
Rhoades, Lawrence Duncan	New Marlborough	Alpha Gamma Rho.
Richter, Otto Hermann	Holyoke	Alpha Sigma Phi.
Rivnay, Ezekiel	Holyoke	56 Pleasant Street.
Robinson, Clifton Fairbanks	Newtonville	Q. T. V.
Robinson, Neil Cooley	Arlington Heights	Phi Sigma Kappa.
Russell, Charles Edwin	West Brookfield	Stockbridge Hall.
Savage, Donald Clifford	South Orange, N. J.	13 Phillips Street.
Sherman, Willis Whitney	Boston	Stockbridge Hall.
Snyder, Allan	Holyoke	Alpha Sigma Phi.
Spelman, Albert Francis	New London, Conn.	3 North College.
Swan, Frederick Walter	Milton	Q. T. V.
Thompson, Arthur Richard	West Bridgewater	83 Pleasant Street.
Verity, Herbert Foster	Woburn	Q. T. V.
Walker, Almeda Marion	Southbridge	Abigail Adams House.
Whitaker, Lewis Harlow	Hadley	Kappa Sigma.
White, John Everett	Abington	Kappa Sigma.
Wiggin, Jennie May	Worcester	Abigail Adams House.
Williams, Earl Fletcher	Whitinsville	Kappa Epsilon.

Class of 1928.

Abrahamson, Howard Joseph	Waltham	Lambda Chi Alpha.
Allen, Leo Linwood Fenton[1]	Athol	Theta Chi.
Allen, Olive Elizabeth	Flushing, N. Y.	Abigail Adams House.
Amatt, Jack	Northampton	Kappa Sigma.
Barnard, Ellsworth	Shelburne Falls	Q. T. V.
Bartlett, Kenneth Alden	Dorchester	Aggie Inn.
Batchelder, Lora Margaret	Easthampton	Abigail Adams House.
Baumgartner, Hans	Pittsfield	11 South College.
Bearse, Gordon Everett	Sharon	Alpha Gamma Rho.
Beeman, Marjorie Elise	Ware	Mt. Pleasant.
Bradford, David Carlton	Springfield	Alpha Gamma Rho.
Bray, Frederick Roland	Amherst	44 High Street.
Bray, Walter Abner	Amherst	44 High Street.
Brockway, Horace Taylor, Jr.	South Hadley	Q. T. V.
Chapman, Dorothy Ann	Newtonville	Abigail Adams House.
Clark, Harold Eugene	Montague	East Experiment Station
Cook, Albert Cairnes	Waverley	12 North College.
Cooke, Dorothy Mabel	Richmond	Abigail Adams House.
Crowley, Francis Jeremiah	Amherst	20 Woodside Avenue.
Cunningham, James Hugh	Quincy	Alpha Sigma Phi.
Davis, Richard Jackson	Arlington	7 North College.
Dean, Carolyn	Utica, N. Y.	Abigail Adams House.
Denton, Ian Oliphant	Norton	27 Fearing Street.
Draper, William Hill, Jr.	Watertown	Kappa Sigma.
Dresser, Horatio Malcom	South Hadley	Alpha Sigma Phi.
Elliott, Lawrence William	Waltham	Lambda Chi Alpha.
Evans, Joseph Andrew	Lawrence	Q. T. V.
Ewer, Seth Judson	Leyden	13 Phillips Street.
Ferguson, Thomas Wells, Jr.	Newton Highlands	Theta Chi.
Flemings, Frederic James	Sharon	Theta Chi.
Forest, Joseph Henry	Arlington	Alpha Gamma Rho.

[1] Candidate for degree of B.Voc.Agri.

ox, Robert Leo	Ware	Q. T. V.
rese, Paul Frederick	Waltham	French Hall.
ifford, Charles Edwin [1]	Sutton	Kappa Sigma.
oldberg, Maxwell Henry	Stoneham	13 South College.
all, Harriet Phœbe	Great Barrington	Abigail Adams House.
all, John Stanley	Lynn	Alpha Gamma Rho.
odson, Alexander Carlton	Reading	Sigma Phi Epsilon.
olland, Bertram Holbrook	Millis	Q. T. V.
omeyer, Frank Fuller	Wellesley Farms	Theta Chi.
owland, Walter Morton	Conway	Alpha Gamma Rho.
yde, William Eaton	Amherst	55 Pleasant Street.
arrer, Robert Joseph	Hingham	Phi Sigma Kappa.
elton, Richard Coolidge	Hubbardston	10 North College.
ennedy, Wellington Waterloo	Red Bank, N. J.	Kappa Epsilon.
idder, Dana Judson, Jr.	Fayville	Theta Chi.
imball, John Adams	Littleton	16 North College.
adas, Constantine Pericles	Boston	11 North College.
ane, Donald Ricker	Brockton	7 North College.
aPrise, Albert Joseph	Great Barrington	Lambda Chi Alpha.
assiter, Elizabeth Ruth	Holyoke	Abigail Adams House.
aubenstein, Karl George	Maynard	1 North College.
awrence, Julia Ruth	Springfield	Abigail Adams House.
eonard, Charles Smith	Chicopee	Lambda Chi Alpha.
eonard, Dorothy Luella	West Springfield	Abigail Adams House.
incoln, Margaret Elizabeth	Shirley	Abigail Adams House.
incoln, Robert Alexander	Hingham Center	Theta Chi.
ittle, Margaret Adams	Newburyport	Abigail Adams House.
oring, Douglas Winthrop	Springfield	Phi Sigma Kappa.
ove, Elizabeth Perry	South Worcester	Abigail Adams House.
arsh, Edwin Elliott	Pittsfield	Q. T. V.
arston, Leon Chester, Jr.	Brockton	27 Fearing Street.
cEwen, Leslie Irving	Winchester	16 North College.
cGuire, Walter Kenneth	Whitinsville	3 North College.
orey, Elizabeth Alma	Wollaston	Abigail Adams House.
oriarty, Robert Earl	Monson	Alpha Gamma Rho.
orland, Harold Laurud [1]	Islington	15 Phillips Street.
orrill, Alfred Clayton	Natick	Phi Sigma Kappa.
ulhern, Daniel Joseph	Roslindale	4 North College.
urch, Ralph Gordon	Holliston	1 North College.
oble, Frank Freeman [1]	Fall River	Q. T. V.
utting, John Lyman	West Berlin	Phi Sigma Kappa.
wers, Robert Hammond	Taunton	Alpha Gamma Rho.
anzica, Josephine	Arlington	Abigail Adams House.
ckett, Thomas Austin	Beverly	84 Pleasant Street.
antinga, Oliver Samuel	Amherst	North East Street.
antinga, Sarah Theodora	Amherst	North East Street.
att, Marjorie Johnson	Dalton	Abigail Adams House.
eston, Charles Putnam	Hathorne	Kappa Sigma.
eston, Stanley Nichols	Hathorne	Kappa Sigma.
octor, Harriet Ellise	South Weymouth	Abigail Adams House.
uinn, John Francis	New Bedford	3 North College.
edgrave, Arnold Ide	Hopedale	Phi Sigma Kappa.
eed, Roland Ellsworth	Greenfield	Lambda Chi Alpha.
ce, Cecil Curtis	Worcester	10 North College.
cker, Albion Barker	Turner, Me.	Lambda Chi Alpha.
oper, Hartwell Eveleth	Closter, N. J.	Alpha Gamma Rho.
an, Edward Parker	Swampscott	Kappa Gamma Phi.
nappelle, Newell Allen	Amherst	25 Amity Street.
nmidt, Ernest John	Longmeadow	Phi Sigma Kappa.
iith, Charles James, Jr.	North Wilmington	Sigma Phi Epsilon.
iith, Leslie Rockwell, Jr.	Hadley	Kappa Sigma.
iith, Walter Russell	Holden	Alpha Gamma Rho.
ıthgate, Barbara Willson	Sea View	Abigail Adams House.
encer, Ernest Leavitt	Lowell	Sigma Phi Epsilon.
atton, Frank	Boston	Alpha Gamma Rho.
livan, Charles Burke	Fall River	16 South College.
omas, Howard	Holyoke	16 North College.
ompson, Frances Clarinda	Amherst	Mt. Pleasant.
ompson, Leonard Lewis	Greenfield	12 North College.
ıll, Henry Bailey	Lowell	Sigma Phi Epsilon.
fts, Warren John	Jamaica Plain	15 North College.
lloch, George Sherlock	Bridgewater	Q. T. V.
ttle, Alden Parker	Bellingham	Baker Place.
n Hall, Walter Bernhardt	Roslindale	Alpha Sigma Phi.
etsch, George Bernard	Greenfield	Sigma Phi Epsilon.
iite, Edwin Searles	Worcester	1 North College.
lder, Edwin Arthur	Sterling Jct.	Phi Sigma Kappa.
lliams, Florence Dorothea	East Norton	Abigail Adams House.
rssam, Horace Herbert	Bernardston	Q. T. V.

Class of 1929.

ıms, Buel Thompson	Dalton	Phi Sigma Kappa.
ıms, Harold Sweetnam [2]	Whitinsville	Alpha Gamma Rho.
ıms, Stephen [1]	Easthampton	M. A. C. Bungalow.
erti, Francis Daniels	Greenfield	22 Fearing Street.

[1] Candidate for degree of B.Voc.Agri.

[2] Admitted on probation; entrance record incomplete.

Ansell, Harold King	Amherst	Kappa Sigma.
Avery, Blanche Deane	Greenfield	Abigail Adams House.
Bailey, Stanley Fuller	Middleborough	2 North College.
Barr, Charles Wesley	Pittsburgh, Pa.	Lambda Chi Alpha.
Bartlett, Irene Lawrence	Rowley	Abigail Adams House.
Bates, Ira Spaulding	Whitinsville	5 Tillson Court.
Berman, Hyman	Woburn	15 South College.
Bern, Philip	Roxbury	14 South College.
Bertenshaw, Edith Louise	Fall River	Abigail Adams House.
Black, Chesley Leman	Reading	97 Pleasant Street.
Blaisdell, Matthew Louis	South Ashfield	Sunderland.
Bliss, Lois Anne	Springfield	Abigail Adams House.
Bond, James Eaton, Jr.	South Lancaster	Alpha Gamma Rho.
Bowie, Robert Lester	East Milton	6 North College.
Brackley, Floyd Earle	Strong, Me.	Alpha Sigma Phi.
Burgess, Emory Dwight	Melrose	Phi Sigma Kappa.
Canney, George Gridley	South Hadley	81 Pleasant Street.
Carlson, Julius Anselm	Brockton	Kappa Sigma.
Carruth, Laurence Adams [1]	Worcester	75 Pleasant Street.
Carter, Warner Harris	Amherst	Amherst, R. F. D.
Chadwick, John Shore	Worcester	Lambda Chi Alpha.
Chapin, Alice Streeter	Sheffield	Abigail Adams House.
Church, Cornelia Bassett	Amherst	North Amherst.
Cleaves, Charles Shepley	Gardner	Phi Sigma Kappa.
Clements, Charles Robert Crofford	Melrose	Phi Sigma Kappa.
Collins, Edgar Winslow	Braintree	Alpha Sigma Phi.
Comins, Lawrence Albert	Millers Falls	West Experiment Stat[ion].
Cook, Florence Mary	Hadley	Abigail Adams House.
Copson, Harry Rollason	Easthampton	18 Chapman Ave[nue], Easthampton.
Coukos, Andrew [1]	Lynn	Kappa Gamma Phi.
Cox, Adelbert Winters	Framingham	9 South College.
Crowley, Dennis Michael	Boston	French Hall.
Davis, Donald Austin	Bedford	21 Fearing Street.
Davis, Kendall Edgar	Springfield	Sigma Phi Epsilon.
Dawe, Ralph Turner	North Adams	Theta Chi.
Day, William Albert Palmer	Watertown	9 Phillips Street.
Devine, John Warren	Arlington	Alpha Gamma Rho.
Dutton, George Wallace	Carlisle	Alpha Gamma Rho.
Dyer, Arnold Walton	Falmouth	Theta Chi.
Eager, Vincent Shattuck	Berlin	Experiment Stati[on] Farmhouse.
Edson, William Gordon [1]	East Braintree	84 Pleasant Street.
Egan, William Ambrose	Springfield	Sigma Phi Epsilon.
Faulk, Ruth Adelaide	Brockton	Abigail Adams House.
Flint, George Bemis	Lincoln	Q. T. V.
Fonseca, Martin Goodman	Allston	M. A. C. Farmhouse.
Fontaine, Mildred	Fall River	Abigail Adams House.
Foster, Thomas William	Sherborn	9 South College.
Frost, Charles Austin	Belmont	15 North College.
Gagliarducci, Anthony Lewis	Springfield	Kappa Epsilon.
Graves, Arthur Hall [1]	Ashfield	Q. T. V.
Grover, Richard Whiting	Cambridge	Alpha Sigma Phi.
Hairston, Jester Joseph	Boston	Colonial Inn.
Hammond, Marjorie Allerton	Onset	Abigail Adams House.
Harrington, Mary Eileen	Holyoke	Abigail Adams House.
Harris, Robert Henry	Greenfield	53 Lincoln Avenue.
Harvey, Herman Chapin	Amherst	9 Spring Street.
Hawley, Guila Grey	Westfield	Abigail Adams House.
Henderson, Everett Spencer	West Hartford, Conn.	3 Nutting Avenue.
Hintze, Roger Thomas	Amherst	Aggie Inn.
Horan, Timothy Joseph	Whitinsville	4 North College.
Howe, Frank Irving, Jr.	Norfolk	Theta Chi.
Hunter, Walter Gordon	South Sudbury	Stockbridge Hall.
Huss, Miriam Hall	Newton Center	Abigail Adams House.
Johnson, Alice Luvanne	Holden	Abigail Adams House.
Johnson, Clifton Russell	Worcester	2 North College.
Jones, Leroy Osgood	Greenfield	12 South College.
Kane, Mary Catherine	Holyoke	Abigail Adams House.
Kay, John Reid	Boston	Kappa Sigma.
Kelley, Charles Edward	Dalton	Phi Sigma Kappa.
Kinney, Asa Foster	South Hadley	9 South College.
Kreienbaum, Roman Albert	Bridgewater	Q. T. V.
Lyman, Warren Hillsgrove [1]	Florence	21 Fearing Street.
Lynch, Elizabeth Anne	Easthampton	Abigail Adams House.
Lynsky, Myer	Boston	9 Fearing Street.
Marsh, Kendall Howe	Holden	Alpha Gamma Rho.
Marx, Walter Herman	Holyoke	10 South College.
McKay, Catherine Mary	Newtonville	Abigail Adams House.
McKittrick, Kenneth Fraser	Boston	Kappa Sigma.
Mills, Taylor Mark	Boston	Kappa Sigma.
Minsuk, Henry George	Springfield	13 South College.
Moore, Ethan Dana	West Springfield	Alpha Gamma Rho.
Morrison, Leonard William	Monson	22 Fearing Street.
Morse, Emily Albertina	Waban	Abigail Adams House.
Nash, Robley Wilson	Abington	11 South College.
Nichols, Edward Holyoke	Montpelier, Vt.	Kappa Sigma.

[1] Candidate for degree of B.Voc.Agri.

iewicz, Boleslaw	Holyoke	Kappa Epsilon.
ary, William Joseph	Northampton	Kappa Gamma Phi.
ard, Faith Evelyn	Windsor	Abigail Adams House.
ish, Ruth Harriet	Great Barrington	Abigail Adams House.
erson, Jane	Amherst	26 Lincoln Avenue.
e, Holton Stebbins	Hampden	Theta Chi.
ins, Esther Janet	Easthampton	Abigail Adams House.
y, Kenneth William	Holliston	Sigma Phi Epsilon.
ney, William Rolland	Willimansett	7 McClellan Street.
ier, Paul Raymond	Adams	Theta Chi.
nson, Hyman Isadore	Springfield	9 North College.
i, Joseph John	North Adams	Sigma Phi Epsilon.
ty, Earl Clinton	Mittineague	Kappa Gamma Phi.
, Robert Drake	Newton	Alpha Sigma Phi.
n, John Michael	Holyoke	83 Pleasant Street.
, Louise Trask	Greenfield	Abigail Adams House.
, Kenneth Merton	Danvers	Q. T. V.
ards, Lawrence Edward	Dalton	Phi Sigma Kappa.
ardson, Evan Carleton	Millis	84 Pleasant Street.
rtson, William Brunner	Port Chester, N. Y.	Phi Sigma Kappa.
quist, Birger John	Boston	83 Pleasant Street.
n, Huntington	North Hadley	North Hadley.
ent, Carmeta Elizabeth	Shrewsbury	Abigail Adams House.
ent, Leonard Fessenden Everett	Greenfield	12 South College.
ens, Harvey William	Greenfield	53 Lincoln Avenue.
nan, Ernest Clark	Malden	Kappa Gamma Phi.
ovitz, Robert	Springfield	9 North College.
t, Gladys Elizabeth [1]	Worcester	Abigail Adams House.
, Grace Gertrude	Allston	Abigail Adams House.
h, Bessie May	West Somerville	Abigail Adams House.
, Robert Sinclair	Southbridge	Care of Mr. Kneeland.
r, Carolyn Emma	Shelburne Falls	Abigail Adams House.
hwick, Walter Edward	Clinton	75 Pleasant Street.
e, Phillips Bradley	Chepachet, R. I.	Phi Sigma Kappa.
bugler, Elizabeth Anne	Brooklyn, N. Y.	Abigail Adams House.
van, John Ayer	Medford	16 South College.
Roy Simpson	Gloucester	8 North College.
er, Frederick Daniels, Jr.	Shrewsbury	Kappa Sigma.
pkins, Earle Alexander	Easthampton	81 Pleasant Street.
tellot, Clarence Sampson	Providence, R. I.	83 Pleasant Street.
ett, Moody Francis	Milford	9 Phillips Street.
nian, Dickran	Springfield	11 North College.
han, Herbert Sidney	Attleboro	Theta Chi.
er, Charles Edward	Millers Falls	13 North College.
den, Charles Edward	Swansea	Q. T. V.
er, Lewell Seth, Jr.	Amherst	19 Phillips Street.
l, Stuart Houghton	Greenfield	Lambda Chi Alpha.
per, Dana Otis	Montague	Colonial Inn.
e, Lawrence Henry	Amherst	42 High Street.
ten, Russell Rutherford	Melrose	Lambda Chi Alpha.
tle, Doris Evelyn	Worcester	Abigail Adams House.
ams, Lloyd George	Pittsfield	Kappa Epsilon.
on, Alexander Charles	Springfield	Kappa Epsilon.
lbury, John Sargent	Fitchburg	Alpha Sigma Phi.
g, Prescott Davenport	North Grafton	3 McClure Street.
ski, John Blaise, Jr.	Holyoke	83 Pleasant Street.

Class of 1930.

s, Charles Streeter	Worcester	21 Fearing Street.
, Herbert Adams	Fitchburg	9 North College.
, Raymond Clayton	Holden	3 Nutting Avenue.
ew, John Albion, Jr.	West Boxford	10 Nutting Avenue.
trong, Robert Lindsey	East Sandwich	60 Pleasant Street.
od, Rachel	Greenfield	Abigail Adams House.
on, Osman	Gloucester	Mt. Pleasant.
y, Headley Edmund	Lucea, Jamaica, B. W. I.	101 Pleasant Street.
y, George Hillman	Hamilton	42 Lincoln Avenue.
s, George Alvan [2]	Lithia	51 Amity Street.
ch, Nelson Edgar	Waverley	86 Pleasant Street.
rd, Harry	Whitinsville	5 Tillson Court.
t, Edward George	Chicopee Falls	14 North College.
n, Carl Augustus	Northampton	70 Lincoln Avenue.
ren, Stina Matilda	Worcester	Abigail Adams House.
rd, Sergius Joseph	North Adams	35 Lincoln Avenue.
gs, Samuel Clark	Belmont	86 Pleasant Street.
p, Frank Millard	Natick	83 Pleasant Street.
inton, John Roswell	Little Compton, R. I.	81 Pleasant Street.
, Richard Henry, Jr.	Needham	Colonial Inn.
n, Jessie Elizabeth	Fitchburg	Abigail Adams House.
n, Mildred Shepard	North Amherst	North Amherst.
n, Phillips Cornelius [2]	Framingham	17 Phillips Street.
er, May Frances	Pittsfield	Abigail Adams House.
nk, Oscar Frank, Jr.	Worcester	30 Fearing Street.
, Theodore Chandler	Taunton	75 Pleasant Street.
Reuben Hillman	Colrain	3 McClure Street.

[1] Candidate for degree of B.Voc.Agri.
[2] Admitted on probation, entrance record incomplete.

Campbell, Harold Vining	Leyden	53 Lincoln Avenue.
Chenoweth, Winifred Lee	North Amherst	North Amherst.
Cleveland, Maurice Mortimer	East Pepperell	97 Pleasant Street.
Cook, Charles Hardy	Beverly	81 Pleasant Street.
Cotter, Monica Quill	Somerville	Abigail Adams House.
Coven, Milton Isadore	Indian Orchard	15 South College.
Cox, Charles Bartlett [1]	Jamaica Plain	29 North Prospect Stre
Crane, Kendall Buck	Millbury	18 Nutting Avenue.
Cunningham, Robert Grey	Quincy	10 North College.
Daniels, Arthur Richards [1]	Dedham	97 Pleasant Street.
Davis, Arnold Mearns	Berlin	5 North College.
Dean, Lucien Wesley	Millis	4 Nutting Avenue.
Decker, Charlotte Marthe	Holyoke	25 Fearing Street.
Denny, Myrtle Althea	Northampton	54 Pleasant Street.
Denton, Edward Wemyss	Norton	33 East Pleasant Street
Dickey, Robert Ira	Merrimac	50 Pleasant Street.
Dix, Raymond Arthur	North Springfield, Vt.	15 Fearing Street.
Donovan, Margaret Pauline	Bondsville	Abigail Adams House.
Dorey, Albert Frank	Belchertown	Belchertown.
Dover, Evelyn	Methuen	Abigail Adams House.
Drew, William Brooks	Greenwich, Conn.	53 Lincoln Avenue.
Eldridge, Francis Kennett [2]	Georgetown	47 East Pleasant Stree
Ellert, Fred Charles	Holyoke	10 South College.
Fenton, John Hopkins	Winthrop	4 Chestnut Street.
Franklin, Paul Lawrence [1]	Springfield	83 Pleasant Street.
Gaumond, Alice Delimen	Southbridge	Abigail Adams House.
Giandomenico, Stephen	Walpole	7 Phillips Street.
Glick, Ina Ervin	Amherst	27 Fearing Street.
Goldberg, Max Charles	Malden	15 South College.
Goodell, Herbert Andrew	Southbridge	42 Cottage Street.
Goodell, Hermon Ulysses	Southbridge	42 Cottage Street.
Goodnow, Robert Gibson	Hopedale	Exp. Sta. Farmhouse.
Grant, William Edward [1]	Boston	17 Triangle Street.
Grunwaldt, Lucy Antoinette	Springfield	Abigail Adams House.
Gunn, Ralph Ellis	South Jacksonville, Fla.	33 East Pleasant Stree
Hale, Henry Fales	Jamaica Plain	84 Pleasant Street.
Haley, Edward Fowler	Orange	17 Phillips Street.
Hall, Addison Smith	Ashfield	53 Lincoln Avenue.
Hammond, Clarence Elliot	Needham	18 Nutting Avenue.
Harris, Charles Whitcomb, Jr.	Leominster	3 Hallock Street.
Haubenreiser, Elsie Martha	Springfield	Abigail Adams House.
Hernan, Richard Alden	Gilbertville	61 Amity Street.
Hetherington, Thomas	Adams	75 Pleasant Street.
Hinchey, Anne Elizabeth	Palmer	Abigail Adams House.
Horwitt, Leonard [1]	Brooklyn, N. Y.	86 Pleasant Street.
Howard, John Brooks, Jr.	Reading	97 Pleasant Street.
Howard, Lucius Alexander	Ridgewood, N. J.	13 North College.
Howard, Martin Stoddard	Northfield, Vt.	97 Pleasant Street.
Howe, Norman Manwaring	Greenfield	35 Lincoln Avenue.
Hunt, Kenneth Whitten	Arlington	Farmhouse.
Hunter, Howard William	Holyoke	83 Pleasant Street.
Ives, Kenneth Gage	Amherst	West Street.
Jacobson, John	North Dartmouth	4 Nutting Avenue.
Jensen, Henry Wilhelm	Jamaica Plain	14 North College.
Johnson, Catharine Genevieve	Amherst	Eames Avenue.
Jones, Fred William	Amherst	137 South Pleasant Str
Joy, John Leo William	Amherst	3 High Street.
Kempt, Harry Charles	Eastham	Baker Place.
Kingsbury, Kermit Kenton	Leominster	3 Hallock Street.
Kneeland, Ralph Folger, Jr.	Attleboro	83 Pleasant Street.
Knight, Kathryn Rachel	Greenfield	Abigail Adams House.
Labarge, Robert Rolland	Holyoke	15 Phillips Street.
Lake, Walter Sidelinger	Plainville	Care of Prof. Banta, S set Avenue.
Lawlor, John Thomas, Jr.	Marblehead	86 Pleasant Street.
Leader, Anthony William	Worcester	8 Allen Street.
Leonard, John Morris	Fall River	14 Nutting Avenue.
Loomis, Randall Miller	Easthampton	22 Pleasant Street, E hampton.
Loud, Miriam Johnson	Plainfield	Abigail Adams House.
Lynds, Lewis Malcolm	Taunton	75 Pleasant Street.
MacCausland, Mabel Alice	West Newton	Abigail Adams House.
Madden, Archie Hugh [1]	Amherst	79 Main Street.
Mann, Raymond Simmons	Dalton	9 Phillips Street.
Marcus, Theodore	Roxbury	15 South College.
Maylott, Gertrude	Worcester	Abigail Adams House.
McChesney, Herbert Lewis	West Springfield	31 Lincoln Avenue.
McIsaac, Donald Weston [2]	East Weymouth	30 Fearing Street.
Miller, Walter Edward	Bethany, Conn.	29 No. Prospect Street
Morawski, Earle Leo	Attleboro	83 Pleasant Street.
Morgan, Isabel Elvira	Schenectady, N. Y.	Abigail Adams House.
Morse, Beryl Florence	Southbridge	Abigail Adams House.
Mullen, Edwin Joseph	Holyoke	83 Pleasant Street.
Murphy, Donald Fraser	Lynn	13 Phillips Street.
Nelson, Gordon	Roslindale	56 Pleasant Street.
Nims, Russell Everett	Greenfield	Colonial Inn.

[1] Admitted on probation, entrance record incomplete.
[2] Candidate for degree of B.Voc.Agri.

'oble, George Watson [1]	Pittsfield	9 Phillips Street.
'oyes, George Hazen	Haverhill	86 Pleasant Street.
'Connor, Eileen	Worcester	Abigail Adams House.
agliaro, Sylvester	Mittineague	Baker Place.
aksarian, John Paul	Franklin	8 Allen Street.
arks, Stillman Harding	Gloucester	8 North College.
atch, Eldred Keene	Stoneham	97 Pleasant Street.
aulson, John Edward	Holyoke	Kappa Epsilon.
hinney, Paul Tirrell	Hyde Park	22 Sunset Avenue.
hinney, Wallace Sanford	Willimansett	7 McClellan Street.
illsbury, William Gale	Amesbury	81 Pleasant Street.
ollin, Ida Edith	Sheffield	Abigail Adams House.
ottala, Arne Eric	Fitchburg	15 Fearing Street.
otter, Stuart Hamilton	Framingham	Farmhouse.
ray, Francis Civille	Amherst	22 Sunset Avenue.
urdy, Wilfred George	Merrimac	50 Pleasant Street.
yle, Arthur Guard	Plymouth	7 Phillips Street.
aplus, Harry Edward	Agawam	97 Pleasant Street.
enaud, Hector Holmes	Walpole	15 Fearing Street.
iley, Vincent Joseph	Somerset	81 Pleasant Street.
obertson, Harold Miner	Leyden	The Davenport.
onka, Lauri Samuel [1]	Gloucester	8 North College.
oot, John Cushman	Plainville	15 Hallock Street.
oper, Harold John	Westminster	3 Hallock Street.
osa, Albert Ulysses	East Boston	
urak, John Walter	Greenfield	60 Pleasant Street.
likorn, Lamchiag Joti	Siam	86 Pleasant Street.
nhorn, Alice Geneva	Attleboro	Abigail Adams House.
ndstrom, Evelyn Cecelia	Auburn	Abigail Adams House.
raceni, Raphael	Lynn	13 Phillips Street.
hantz, Joseph Harvey	Allentown, Pa.	86 Pleasant Street.
rima, Paul Andres	Monson	Baker Place.
derquist, Arthur Butman, Jr.	Auburndale	45 Pleasant Street.
epard, Moody Lawrence [2]	West Boylston	3 Nutting Avenue.
ngleton, Eric	Brooklyn, N. Y.	35 Lincoln Avenue.
ois, John Joseph [1]	Andover	35 Lincoln Avenue.
ogsberg, Frank Albert [2]	Worcester	3 Nutting Avenue.
eeper, Ralph Emerton	Rowley	13 Phillips Street.
nith, Raymond Francis	Needham	Colonial Inn.
nith, Reginald DeWitt [1]	West Springfield	31 Lincoln Avenue.
nith, Winthrop Grant	Needham Heights	83 Pleasant Street.
ooner, Laurence Whipple	Brimfield	20 Lessey Street.
acy, Paul	Webster	17 Phillips Street.
anford, Spencer Clarendon	Rowe	22 Sunset Avenue.
anisiewski, Leon	Amherst	Triangle Street.
evenson, Errol Burton	Brockton	86 Pleasant Street.
one, Ruth Winifred	Holyoke	Abigail Adams House.
her, Maurice	Holyoke	56 Pleasant Street.
llivan, Pauline Eugenia [1]	Bangor, Me.	Abigail Adams House.
llivan, William Nicholas, Jr.	Lawrence	5 North College.
ett, Margaret Elizabeth	Gloucester	Abigail Adams House.
ift, Frances Harrington	Springfield	Abigail Adams House.
ift, Gilbert Dean	Melrose	54 Lincoln Avenue.
ft, Jesse Alderman	Mendon	Exp. Sta. Farm House.
ft, Roger Sherman	Sterling	Care of E. F. Gaskill.
nk, John Richard	Chatham, N. Y.	15 Phillips Street.
atcher, Christine Belle	Cummington	33 Lincoln Avenue.
fany, Don Cecil	Cambridge	83 Pleasant Street.
ton, Arthur Francis, Jr.	Salem	21 Fearing Street.
mfohrde, Karl Martin	West Somerville	3 Hallock Street.
dryn, Edward William	Hadley	21 Fearing Street.
dleigh, Cecil Herbert	Milford	Exp. Sta. Farm House.
echter, Peter Hansen, Jr.	Walpole	15 Fearing Street.
rren, Allen Johnson	New Haven, Conn.	45 Pleasant Street.
lls, Marie Evelyn	Pugwash, Nova Scotia	Abigail Adams House.
ite, Frank Tisdale, Jr.	Holbrook	81 Pleasant Street.
ite, Harold James	Brighton	11 South College.
lliams, Inez Wilhelmina	Brockton	Abigail Adams House.
od, Priscilla Grover	West Bridgewater	Abigail Adams House.
odcock, Alfred Herbert	Daytona Beach, Fla.	45 Pleasant Street.
odin, Elizabeth Marie	Adams	Abigail Adams House.
atman, Alwyn Frederick	Springfield	66 Pleasant Street.
ung, Edward Henry	Northampton	84 Pleasant Street.
ger, Albert Peter	New Haven, Conn.	4 Chestnut Street.

Special Students.

ibbe, Daniel McEwen	Toms River, N. J.	The Davenport.
rney, Norbert Joseph	Attleboro	Baker Place.
yne, Donald Tubbs	Dunstable	8 Allen Street.
ran, Mayer	Malden	56 Pleasant Street.

Registered after Catalogue for 1926 was published.

1926.

ckley, Arthur Vincent . . . . Natick.

[1] Admitted on probation, entrance record incomplete.
[2] Candidate for degree of B.Voc Agri.

Special Students.

Arthur, May G.	Northampton.
Campbell, Frederic Lloyd	St. John, N. B.
Cutler, Walter Leon	Amherst.
Denny, Iva	Northampton.
Kilpatrick, Charles J.	Northampton.
Lundblad, Carl A.	Northampton.
Peabody, Robert W.	Waverley.

Summary by Classes.

Class.	Men.	Women.	Total.
Graduate students	33	6	39
Seniors, 1927	77	10	87
Juniors, 1928	89	21	110
Sophomores, 1929	115	30	145
Freshmen, 1930	150	35	185
Specials	4	–	4
Totals	468	102	570

Geographical Summary.

Massachusetts	522	Michigan	
Rhode Island	3	Indiana	
Connecticut	8	Florida	
Maine	4	Canada	
Vermont	3	British West Indies	
New Hampshire	1	Hungary	
New York	8	Russia	
New Jersey	6	Siam	
Delaware	1		
Pennsylvania	2	Total	5
Colorado	1		

Short Course Enrollment.

Two-Year Graduates, 1926.

ıdam, Samuel S.	Swansea.
ılcott, Elverton Hunting	Brookline.
ımes, Bessie Bell	Center Marshfield.
ınderson, Frederic	Grafton.
ıpelquist, Philip Eugene	Orange.
ıassett, Sherrold Emerton	Everett.
ılood, Charles Andrew Fletcher	Pepperell.
ıradley, Howard Courtland	Seekonk.
ırown, Charles Franklin	Worcester.
ıurgevin, Paul Louis	Port Chester, N. Y.
lapp, Irving Miller	Northampton.
lark, Stewart Floyd	Conway.
ogswell, Sarah Ellen	Westborough.
rocker, Ralph Herman	Holliston.
avidson, Henry Wilbur	Auburn.
avis, Charles Ellsworth	North Adams.
eLano, Frederic Lewis	Richmond Hill, N. Y.
eLorenzo, Joseph, Jr.	Kingston.
esrosiers, Adolphe Biron	Orange.
onnelly, Edward Boyce	Waltham.
oster, William Edward	Ipswich.
oldthwaite, Ernest	Dunstable.
Iawes, Ralph Edmund	Sudbury.
Iayden, Charles Ernest	Newtonville.
Ierron, Frank Robert	Greenfield.
Iess, Frank Wesley	Springfield.
Iumphrey, Leo Harris	Medford.
Iyde, Gerald	Buzzards Bay.
ohnson, Gunnar Theodore	Leicester.
ohnson, Tage Frederick	Milton.
̆aakinen, Theodore	Fitchburg.
ıadd, Joseph Mark	Worcester.
ıahey, Jeremiah Joseph	Plymouth.
ıeoncini, Louis John	Hopedale.
Iaclean, Theodore Elwin	Spencer.
Iarkert, Ernest Frederick	Amherst.
Iassa, Andrew Louis	East Boston.
Iathew, George Williams, Jr.	Boston.
IcCurdy, John	Gardiner, Me.
Ieeker, Alice Maude	Ludlow.
Iellen, James Dwight	Athol.
Iash, Alexander Allaire	Mattapoisett.
Iewhall, Benjamin Weston	Danvers.
utter, Richard Louis	Melrose.
arsons, Philip Hinde	Manchester.
earse, William Thomas	Rockland.
routy, Homer Spooner	Furnace.
utnam, Frank Wendell, Jr.	West Newton.
ichards, Foster Herbert	Lowell.
iley, Ernest Francis	Dedham.
oot, Worth Stewart	Colrain.
owell, Elisabeth Johnson	Groton.
ıfran, Mayer	Malden.
ıwyer, Roland Willard	Groton.
ıelnut, Charles Francis	South Boston.
nith, Edith Caswell	Wakefield.
ıllivan, Maurice Laurence	Peabody.
owne, Milton Curtis	Petersham.
ribe, Gordon Stanley	Somerville.
ruelson, Stanley Dunham	Somerville.
arnum, William Parker	Collinsville.
'alker, Roger Francis	South Sudbury.
'etherbee, Roger Frederick	Townsend Harbor.
'hitcomb, Janet	Haverhill.
'ilson, Herbert Ralph	Chelsea.
'ood, Helen May	Stoughton.
ocum, Margaret Gardner	Wooster, Ohio.

Second Year Two-Year Students, 1926–27.

Aalto, Nestor Armas	Osterville	Box 213, M. A. C.
Anderson, Ralph Welman	Dorchester	Care of Mrs. Webb, Bak Lane.
Andrews, Herman George	Southampton	Care of Mrs. Sheffiel North Amherst.
Atwood, Donald Meredith	North Abington	83 Pleasant Street.
Bennett, Dorothy Dunbar	Watertown	Abigail Adams House.
Bird, James Henry	West Roxbury	12 South College.
Boelsma, Harmen	Hingham	Sunset Avenue, care Professor Banta.
Bradley, Charles Luther	Lee	Care of Mrs. Webb, Bak Lane.
Bullard, Rachel Althea	Orange	Abigail Adams House.
Burrill, Arthur Webster	Wellesley	A. T. G., North Colleg
Burt, Percy Leighton	Vineyard Haven	4 Chestnut Street.
Caffrey, William James	Cromwell, Conn.	Kolony Klub.
Callahan, Kathleen Sara	Dorchester	Abigail Adams House.
Cover, Frederick Brooke	Lowell	Box 272, Belchertown.
Elder, Roy Wentworth Rockwell	Waverley	97 Pleasant Street.
Felton, Lindley	Marlborough	A. T. G., North Colleg
Fitzgerald, Elmer Smith	Leominster	Kolony Klub.
Fullam, Kenneth Bullard	North Brookfield	56 Pleasant Street.
Fuller, Lucia Baldwin	Belmont	Abigail Adams House.
Gale, Merton Stuart	Gardner	56 Pleasant Street.
Gay, Edward Ernest, Jr.	Belchertown	Belchertown.
Gibbs, John Edward	Nantucket	A. T. G., North College
Graves, Lyman William	Conway	9 Mt. Pleasant.
Hall, George Winston	Dudley	Kolony Klub.
Hallbourg, Robert Francis	Westfield	17 Kellogg Avenue.
Hannigan, Michael Joseph	Milford	Baker Lane.
Hawkes, Louis Peter	Buckland	14 McClellan Street.
Hayward, Francis Dean	Holden	5 Tillson Court.
Holland, Leslie Clayton	Holyoke	Kolony Klub.
Hoxie, Edward Graham	Dalton	138 South Pleasant Stree
Kenyon, Bernard Holden	Winchendon	Tillson Farm Experime Station.
Ketchen, Andrew Gilmore	Belchertown	Belchertown.
King, Arthur Hamilton	Woburn	Kolony Klub.
Knox, Barbara Howard	Taunton	Abigail Adams House.
Marks, Stanley Emery	East Lynn	Kolony Klub.
Mason, George Arthur	Somerville	Kolony Klub.
Mason, Harold C.	Princeton	Kolony Klub.
May, Arthur Howard	Bernardston	Bernardston.
Nicolai, Mario	Somerville	Care of Mrs. Webb, Bak Lane.
Nielsen, Henning Olav	Amherst	9 College Avenue.
Nilsson, Gustaf Carl	Worcester	Kolony Klub.
O'Neil, Eugene Francis	Amherst	52 Whitney Street.
Parker, Alfred Henry	East Pepperell	Kolony Klub.
Parsons, Harold Kenneth	Brooklyn, N. Y.	24 McClellan Street.
Peabody, Samuel Sumner	Manchester	86 Pleasant Street.
Pickard, Ashley Houghton	Littleton	Kolony Klub.
Pitt, Charles Randall	Bridgeport, Conn.	Kolony Klub.
Plude, Alfred Edward	Somerville	12 Chestnut Street.
Post, Philip Malcolm	Worcester	31 East Pleasant Street.
Pratt, Martha Elizabeth	Hadley	116 Pleasant Street.
Price, Ruth	North Attleborough	Abigail Adams House.
Roy, John Plimpton	North Adams	Kolony Klub.
Russ, Sherman Wilder	Sunderland	Sunderland.
Scott, Raymond Earle	Pepperell	7 McClellan Street.
Sennott, Miriam Katherine	West Roxbury	Abigail Adams House.
Shepard, Lucius Colton	Princeton	35 East Pleasant Street.
Sime, Frederick Oliver	North Weymouth	Kolony Klub.
Smith, Frank Pellman	Somerville	Care of Prof. Sears, M Pleasant.
Smith, Ralph Wesley	Hyde Park	Kolony Klub.
Smith, Roland Whipple	Quincy	A. T. G., North College.
Smyth, James William	Jamaica Plain	8 Kellogg Avenue.
Stewart, Harold Edward	West Boylston	86 Pleasant Street.
Sweet, Howard Arthur	Norton	45 Fearing Street.
Tefft, Volney Vanderneer	Ashby	Aggie Inn.
Vincent, Archer William	Townshend, Vt.	A. T. G., North Colleg
Vining, Kenneth Rogers	New Bedford	30 Lincoln Avenue.
Waldo, Theodore Elias	Boylston Centre	Care of Mrs. Webb, Bak Lane.
Warren, Lawrence Philip	Westborough	45 Fearing Street.
Watson, Neil Buster	Flint, Mich.	108 Pleasant Street.
Weeks, Janet	Somerville	Abigail Adams House.
Whitcomb, Oliver Adams	Littleton	Kolony Klub.
Whithed, Morton Ernest	Bernardston	3 Nutting Avenue.
Whitmore, Edwin Ervin	Campello	Kolony Klub.
Wile, Ira Rigby	New York, N. Y.	Baker Lane.
Winslow, Rex Parker	Worcester	17 Kellogg Avenue.
Woodbury, Donald Frederick	Sunderland	Sunderland.
Young, Edwin Ralph	Worcester	86 Pleasant Street.
Zaik, Frank Leo	East Brookfield	A. T. G., North College.

First Year Two-Year Students, 1926–27.

ker, Daniel Wallace	Brighton	37 Pleasant Street.
llard, Alden Chester	North Adams	Eames Avenue.
tchelor, Warren Arthur	Stoughton	3 McClure Street.
rgman, Leroy Leonard	Orange	7 East Pleasant Street.
idges, Mildred Frances	West Brookfield	Abigail Adams House.
tcher, Sydney Edward	North Amherst	North Amherst.
tler, Bradford Henry	Newburyport	84 Pleasant Street.
tters, Alden William	Natick	70 Lincoln Avenue.
llahan, Eileen Mary	Dorchester	Abigail Adams House.
ace, William Stuart	South Dartmouth	55 Amity Street.
ırk, Robert William	Springfield	9 Fearing Street.
ırke, Raymond Davenport	East Brimfield	22 Sunset Avenue.
ok, Errol Francis	Waltham	45 Pleasant Street.
well, Arthur Desmond	South Brewster	3 Allen Street.
vis, Eber Hammond	Rutland, Vt.	1 Cottage Street.
nnett, Charles Norman, Jr.	Amesbury	81 Pleasant Street.
nnett, John Bradford	Plympton	46 McClellan Street.
dds, Richard Wright	Littleton	8 Allen Street.
herty, John Joseph	Woburn	3 Allen Street.
ran, Robert Edward	Lexington	3 Hallock Street.
redge, Eunice Constance	Chatham	Abigail Adams House.
ott, George Ramon	Groveland	66 Pleasant Street.
ery, Malcolm Small	Foxborough	75 Pleasant Street.
erty, Richard Daniel	Newton	9 College Avenue.
den, Halmar William	Brockton	Baker Lane, care of Mrs. Webb.
loury, Edgar Anthony	Dudley	6 Kellogg Avenue.
liver, Sydney Joseph	New Haven, Conn.	60 Pleasant Street.
ham, Herbert Walker	Marlborough	44 High Street.
ıcock, Joan	Montreal, Que., Can.	Abigail Adams House.
ks, Edward Ernest	Holyoke	183 Pearl Street, Holyoke.
fman, Ludwig	Rockville, Conn.	21 Pleasant Street.
vey, Stuart Woodbury	Dracut	35 Lincoln Avenue.
kson, Sulo	Osterville	68 Lincoln Avenue.
ett, Lloyd Wendell	Middlebury, Vt.	10 Nutting Avenue.
nson, Earling Christian	Everett	3 McClellan Street.
nson, Herbert Fox	Allston	Care of Mrs. Webb, Baker Lane.
ıe, Harry Busse	Amsterdam, N. Y.	73 Pleasant Street.
logg, Charles Goodrich	Benson, Vt.	68 Lincoln Avenue.
ıball, George Warren	Westford	8 Allen Street.
ned, Ruth Edwina	Amherst	No. Pleasant Street.
rson, Harry LeRoy	Brockton	14 McClellan Street.
rson, Thomas Wing	North Dartmouth	55 Amity Street.
es, Frank Luce	Vineyard Haven	68 Lincoln Avenue.
:Intyre, John Wesley	Springfield	Care of Mr. Sheffield, Pine Street, North Amherst.
ldocks, Lewis Henry, Jr.	Dracut	29 Lincoln Avenue.
chant, John Chesley	Boston	86 Pleasant Street.
vberry, Harold Edmunds	Northborough	46 McClellan Street.
calf, Earl D.	Weld, Me.	Care of Mrs. Webb, Baker Lane.
chell, Samuel Stetson	Salem	84 Pleasant Street.
oli, Thomas	Lexington	27 Cottage Street.
ıon, Sidney Parkhurst	Boston	86 Pleasant Street.
n, Ralph Edwin	Waverley	97 Pleasant Street.
ns, Albert Joseph	Prospect Plains, N. J.	30 Lincoln Avenue.
, Albert Harrington	Framingham	37 Pleasant Street.
ıit, Andrew Stephen	Mansfield	76 Main Street.
rsen, Bradley Huston	Worcester	83 Pleasant Street.
ard, James William	North Adams	83 Pleasant Street.
itt, Frank Willard	Westborough	46 McClellan Street.
er, Robert Edward	Saugus	10 Nutting Avenue.
ifer, Howard George	Natick	70 Lincoln Avenue.
ouin, Henry Victor	Windsor	21 Pleasant Street.
dall, Alice Ravenia	Belchertown	Abigail Adams House.
l, Milton, 2nd	Taunton	30 Lincoln Avenue.
l, Myrton Starkey	Belmont	45 Fearing Street.
ey, John Cheney	South Weymouth	30 Fearing Street.
ıe, Gerald Brendon	Charlestown	8 Beston Street.
mell, George J.	Dorchester	9 College Avenue.
ıders, Blanche M.	Brewster, N. Y.	Abigail Adams House.
, Walter Thomas	Springfield	Care of Mr. Sheffield, Pine Street, North Amherst.
kpole, Alan Douglas	Arlington	56 Pleasant Street.
ley, Richard Harry	Templeton	66 Lincoln Avenue.
kweather, Oscar Allan	Needham	7 East Pleasant Street.
kwell, Cecil Gordon	Amherst	4 Chestnut Street.
ell, Dwight Kenneth	New Salem	21 Woodside Avenue.
or, Oscar Banks	Green's Farms, Conn.	30 Lincoln Avenue.
h, Thomas Burton	Amherst	35 East Pleasant Street.
ren, Isadora Mildred	Westfield	Abigail Adams House.
s, Arthur William, Jr.	Dracut	35 Lincoln Avenue.
more, Herbert Alston	Worcester	66 Lincoln Avenue.
ox, Charles Field	North Wilmington	44 High Street.
ox, Philip Alan	Windsor, Vt.	Box 5, Stockbridge Hall.

Willey, Giles Hyman	Essex Junction, Vt.	1 Cottage Street.
Winkler, Eleanor King	Wakefield	Abigail Adams House.
Wood, Francis Deane	Belfast, Me.	75 Pleasant Street.
Woodhead, Paul Anthony	Chelmsford	41 Pleasant Street.
Wyman, Harold Frank	Leominster	41 Pleasant Street.
Yarrows, Frank Joseph	Hatfield	Hatfield.

Vocational Poultry Course, 1926.

Barker, Samuel Prnyn	Assinippi	45 Fearing Street.
Chase, Rolfe Baker	Taunton	45 Fearing Street.
Dewar, Charles Duncan	Dedham	30 Fearing Street.
Grant, Loyal William	Fall River	Care of Prof. Banta, [illegible]set Avenue.
Rogers, John Saltonstall	South Orleans	18 Nutting Avenue.
Trefry, Arthur William	Lynn	18 Nutting Avenue.

Winter School, 1926.

Aldrich, Elbert C.	Granby.
Anderson, Esther E.	South Manchester, Conn.
Andreson, James	Worcester.
Atkins, Lawrence	Charlemont.
Barbey, John	Montmollin, Switzerland.
Barnhart, L. F.	Stoneham.
Bellman, Sturgis	Cotuit.
Bolles, Mrs. C. E.	Amherst.
Boyden, Wm. E.[1]	North Hanover.
Branch, Herbert C.	Lonsdale, R. I.
Bridges, G. Edwin	Newfield, Me.
Byons, Thomas E.	Irvington, N. J.
Campbell, Edward	Clinton.
Cardinal, Gerard E.	Malden.
Craig, Donald W.	Weymouth.
Carroll, Helen L.	Hanover.
Crosby, Leonard E.	Oxford.
Dutton, Edward A., Jr.	East Craftsbury, Vt.
Duwell, Mrs. H. J.	Amherst.
Eaton, Ellis L.	Northampton.
Erickson, James E. V.	Hartsville.
Frost, Clarence A.	Westford.
Gage, Nandell P.	North Craftsbury, Vt.
Gilchrest, Ray W.	Fall River.
Glesmann, Edward	Holyoke.
Gordon, George F.	Ipswich.
Goss, C. Lucius A.	Amherst.
Heinold, Edwin	Clinton.
Hewins, Lawrence	Walpole.
Holbrow, John C.	Dorchester.
Holmes, Henry P.	Brighton.
Howland, William W.	Springfield.
Johnson, James W.	Orange.
Kalberg, Mildred	Marshfield Centre.
Kraemer, Carl A.	Clinton.
Levine, Sophie	Springfield.
Martin, Everett L.	Cheshire.
McLay, John J.	North Andover.
Mellen, Howard	Shrewsbury.
Merritt, Milton E.	Somerville.
Miller, William A., Jr.	Conimicut, R. I.
Mitchell, Robert L.	Salem.
Monk, Stanley E.	Auburn, Me.
O'Neil, Kathleen	Dorchester.
Parker, Reginald S.	Milford.
Pearse, John N.	Rockland.
Phinney, Elizabeth F.	Amherst.
Pierce, Edward S.	Barre, Vt.
Quimper, Anthony A.	Westfield.
Quinn, Woodville P.	New York, N. Y.
Rosenbaum, Abraham	North Westchester, Conn.
Sharp, Mrs. Dallas L., Jr.	Hingham.
Sheffield, Howard	North Amherst.
Sloane, Alvin	Somerville.
Sonstroem, John R.	Bristol, Conn.
Sorenson, Christopher	Greenfield.
Stark, Charles D.	Ashfield.
Stewart, Ernest	North Andover.
Taylor, Charles	Whitman.
Taylor, Mary H.	Amherst.
Towne, Milton C.	Petersham.
Treblas, P. J.	Northampton.
Waite, John A.	Lexington.
Walsh, John A.	Watertown.
Williams, Paul	Northampton.
Williamson, James S.	Dudley.
Worth, Harry V.	New Bedford.
Zimmele, G. B.	Jamaica Plain.

[1] Deceased.

Summer School, 1926.

Graduate School Students.

noit, Helen A.	Amherst.
chanan, Walter G.	Methuen.
veney, John J.	Amherst.
wing, William A.	West Springfield.
ain, Brooks D.	Amherst.
nn, Alan F.	Sagamore.
ller, James E.	Colorado Springs, Col.
rvey, Mary E.	Amherst.
odwin, Hope C.	North Amherst.
odwin, William I.	North Amherst.
lloran, Elizabeth	Northampton.
milton, William B.	St. Lambert, Que., Can.
menway, Justin S.	Williamsburg.
k, Melvin C.	Amherst.
ly, Leslie M.	Amherst.
ly, Oliver W.	Amherst.
ehan, Mary D.	Amherst.
yo, William I.	Northampton.
Donnell, Anna H.	Florence.
rien, Mary C.	Greenfield.
onnell, Mary E.	Northampton.
ley, Marion G.	Amherst.
nd, Lena A.	Wethersfield, Conn.
s, Charles F.	Lee.
unno, Noreda A.	Syracuse, N. Y.
nan, Kenneth A.	Needham.
ong, Ruth A.	Amherst.
ver, Alfred L.	North Amherst.
ner, Charles E.	Springfield.

Enrollment — Not Graduate School.

n, Elizabeth M.	Amherst.
n, Francis S.	Belchertown.
n, Thomas S.	Belchertown.
lerson, Isabel	Dorchester.
low, Harry E.	Amherst.
low, Mrs. Helen	Amherst.
low, Helen A.	Amherst.
vea, Beatrice M.	Bridgewater.
gham, Harold C.	Nashua, N. H.
ven, Ruth	Keene, N. H.
oks, Mrs. Charles	Mangume, N. C.
oks, Marguerite T.	Boston.
wn, Mildred S.	North Amherst.
wn, Richard B.	Northampton.
kley, Arthur V.	Natick.
ker, Amy H.	Northampton.
son, Oscar E.	Boston.
pman, Gean M.	Bradford.
pman, Lena	Amherst.
noweth, Winifred L.	North Amherst.
rch, Cornelia B.	North Amherst.
ord, Mary A.	Springfield.
well, Archibald G.	Lynn.
lan, Bertha A.	Cambridge.
nelly, Helen M.	Dorchester.
nelly, Margaret M.	Dorchester.
x, Grace W.	Peabody.
x, Martha A.	North Amherst.
son, Harry R.	Easthampton.
oran, Mary E.	Holyoke.
enden, Viola E.	Beverly.
mings, Maurice A.	Cambridge.
mings, Mrs. Edna D.	Holyoke.
ningham, Alice	Winthrop.
er, Samuel	Springfield.
y, Margaret	Conway.
ahue, Margaret L.	Roslindale.
e, Margaret L.	Natick.
owski, Anna	Deerfield.
er, Edward M.	Sunderland.
er, Eleanor	Sunderland.
rson, Elizabeth J.	Amherst.
son, Bettina L.	Amherst.
on, Mary B.	Northampton.
y, Dora C.	Enfield.
d, Elizabeth L.	Amherst.
am, Elizabeth	Amherst.
t, John F.	South Hadley.
naway, J. Emerson	Springfield.
ey, Charles L.	Chicopee.
es, Anna C.	East Boston.
iman, David E.	Longmeadow.
ison, Arthur K.	Amherst.

Hawley, Mrs. Edna B.	Amherst.
Hickey, Rose M.	North Cambridge.
Hinds, Elizabeth	Winchester.
Hintze, Harold S., Jr.	Amherst.
Holleran, Frances M.	Roslindale.
Hynes, Ralph W.	Holyoke.
Irwin, Mrs. Elizabeth C.	Amherst.
Jones, Mildred	Houlton, Me.
Joy, John L.	Amherst.
Kelley, Margaret L.	Amherst.
Kidger, Mrs. Marion P.	Newtonville.
King, Kathleen G.	South Amherst.
Kingsbury, Eleanor G.	Holyoke.
Lacey, Austin L.	Northampton.
Lassiter, Elizabeth R.	Holyoke.
Lenigan, Margaret L.	Holyoke.
Lyman, Jennie I.	Amherst.
Lyman, Laura E.	Amherst.
MacNally, Alice	Roxbury.
Marshall, Maud A.	Amherst.
Martin, Margaret A.	Amherst.
McMorrow, Frances B.	Boston.
Medve, Elizabeth	Lawrence.
Meyer, Beatrice F.	Amherst.
Miller, Margaret E.	Hadley.
Mitten, Elizabeth M.	Amherst.
Moriarty, Margaret M.	West Roxbury.
Morse, Alice L.	Roxbury.
Morse, Ellen H.	Amherst.
Morton, Sylvia S.	Conway.
Murdough, Edwin L.	Springfield.
Murray, Anna E.	Dorchester.
Newcomb, Bertha A.	Deerfield.
Newcomb, Roxie A.	Deerfield.
Newport, Florence E.	Amherst.
Noble, Frank F.	Fall River.
Nolan, Helena M.	Dorchester.
Nolan, Mrs. Katherine M.	Dorchester.
Nolan, Mary F.	Dorchester.
O'Connor, Deborah	Worcester.
O'Connor, Margaret A.	Northampton.
O'Connor, Mary	Northampton.
O'Leary, John T., Jr.	Northampton.
Percy, Myrtle L.	Ashfield.
Pickering, Dorothy N.	Amherst.
Power, Anne W.	Dorchester.
Pray, Mrs. F. C.	Amherst.
Preble, Laura E.	Dorchester.
Pushee, George F.	North Amherst.
Reed, Mrs. Edna W.	North Amherst.
Regan, Alice C.	Roslindale.
Reidy, Blanid M.	Worcester.
Richards, Robert S.	Melrose.
Ricker, Albion B.	Turner, Me.
Roberts, William	Amherst.
Ross, Hazel A.	Northampton.
Roulston, Alice G.	Mattapan.
Rudquist, Birger J.	Boston.
Rundquist, Edna J.	Gloucester.
Ruth, Dorothea C.	Dorchester.
Sawyer, Louise W.	Fitchburg.
Searle, Jean	Amherst.
Shaw, Doris E.	Amherst.
Shea, Eleanor B.	Springfield.
Shea, Margaret M.	Springfield.
Shumway, Sara S.	Monson.
Slack, Grace G.	Allston.
Solov, Mrs. Agnes H.	Winchester.
Stalker, Louise M.	Dorchester.
Stanisiewski, Peter F.	Amherst.
Strong, Dwight	Amherst.
Sullivan, Mary G.	Roslindale.
Taylor, Mrs. Carolyn G.	Springfield.
Thayer, Eileen	Amherst.
Thompson, Rufus H.	Amherst.
Thornton, Mary	Amherst.
Villalobos, Catalina	New York, N. Y.
Walsh, Mrs. Elizabeth	Amherst.
Ward, Eleanor	Amherst.
Whitney, Barbara	Springfield.
Whittle, Doris E.	Worcester.
Wilson, Julia M.	Amherst.
Wood, Basil B.	Amherst.
Wright, Frederick	Amherst.
Wright, Mrs. Rosalie R.	Amherst.

STUDENTS REGISTERED AFTER THE CATALOGUE FOR 1925–26 WAS PUBLISHED.

Two-Year Course.

rl, Sidney G. . . . . Hatfield.

Vocational Poultry Course.

ther, John Chester . . . . Northborough.

SUMMARY OF SHORT COURSE ENROLLMENT.

	Men.	Women.	Total.
o-year Course, second year	69	9	78
o-year Course, first year	78	9	87
cational Poultry Course	6	–	6
nter School, 1926	58	10	68
mmer School, 1926	51	116	167
Totals	262	144	406

INDEX.

MASSACHUSETTS AGRICULTURAL COLLEGE

BIENNIAL REPORT OF THE MASSACHUSETTS AGRICULTURAL EXPERIMENT STATION

REPORT OF THE DIRECTOR FOR THE FISCAL YEARS ENDING NOV. 30, 1925 AND 1926, PUBLISHED IN ACCORDANCE WITH THE PROVISIONS OF SECTION 32 OF CHAPTER 30 OF THE GENERAL LAWS

Being Parts III and IV of the Sixty-Fourth Annual Report of the Massachusetts Agricultural College

A Record of the Forty-Third and Forty-Fourth Years from the Founding of the State Agricultural Experiment Station

DEPARTMENT OF EDUCATION
THE COMMONWEALTH OF MASSACHUSETTS

'UBLICATION OF THIS DOCUMENT APPROVED BY THE COMMISSION ON ADMINISTRATION AND FINANCE

. 9-'27. Order 9936.

Officers and Staff.

TRUSTEE COMMITTEE.

STATION STAFF.

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Joseph B. Lindsey, Ph.D., *Vice-Director*.
Fred C. Kenney, *Treasurer*.
Basil B. Wood, A.B., *Librarian*.
Edwin F. Gaskill, B.Sc., *Assistant to the Director*.
Mrs. Lucia G. Church, *Secretary to the Director*.
Miss F. Ethel Felton, A.B., *Editorial Assistant*.

Agricultural Economics.

Alexander E. Cance, Ph.D., *Professor*.
Robert J. McFall, Ph.D., *Research Professor*.
Miss Lorian P. Jefferson, M.A., *Assistant Rese ch Professor*.
Hubert W. Yount, M.Sc., *Assistant Research Profess*
Miss Ruth E. Sherburne, B.Sc., *Laboratory Assista*
Miss Marian V. Brown, B.A., *Clerk*.

Agronomy.

Arthur B. Beaumont, Ph.D., *Professor*.
John P. Jones, Ph.D., *Research Professor*.
Robert S. Horne, B.Sc., *Investigator*.
Miss Ethel M. Wood, *Clerk*.

Botany.

A. Vincent Osmun, M.Sc., *Professor*.
William L. Doran, M.Sc., *Research Professor*.
Emil F. Guba, Ph.D., *Assistant Research Professor*. (Market Garden Field Station, Waltham.)
Linus H. Jones, Ph.D., *Assistant Research Professor*.
Miss Gladys I. Miner, *Curator*.
Alyn S. Ball, *Laboratory Assistant*.
Miss Mary F. Kent, *Stenographer*.

Cranberry Station.

Henry J. Franklin, Ph.D., *Research Professor in Char*. (East Wareham.)
Joseph L. Kelley, *Investigator*. (East Wareham.)

Dairy Manufactures.

Julius H. Frandsen, M.S.A., *Professor*.
Arthur W. Phillips, A.M., *Assistant Research Profes r.*

Entomology.

Henry T. Fernald, Ph.D., *Professor*.
Arthur I. Bourne, A.B., *Assistant Research Professor*
Warren D. Whitcomb, B.Sc., *Assistant Research Profes*. (Market Garden Field Station, Waltham.)
Miss E. M. Kiley, *Stenographer*.

Farm Management.

James A. Foord, M.Sc., *Professor*.

ome Economics.	Miss Esther S. Davies, Ph.B., B.S., *Assistant Research Professor.*[1]
orticultural anufactures.	Walter W. Chenoweth, M.Sc., *Professor.* Carl R. Fellers, Ph.D., *Research Professor.*
·getable Gardening ıd Market Garden eld Station.	Victor A. Tiedjens, M.Sc., *Assistant Research Professor.* (Market Garden Field Station, Waltham.) Miss Edith E. Meehan, *Stenographer.* (Waltham.)
eteorology.	John E. Ostrander, A.M., C.E., *Meteorologist.*
icrobiology.	Charles E. Marshall, Ph.D., *Professor.*[2] Leon A. Bradley, Ph.D., *Assistant Research Professor.*
ant and Animal ıemistry.	Joseph B. Lindsey, Ph.D., *Chemist.* Edward B. Holland, Ph.D., *Research Professor.* Fred W. Morse, M.Sc., *Research Professor.* Carlton P. Jones, M.Sc., *Assistant Research Professor.* John G. Archibald, M.Sc., *Assistant Research Professor.* Paul Nelson, B.Sc., *Investigator.* Harry L. Allen, *Laboratory Assistant.* James R. Alcock, *Assistant in Animal Nutrition.* Miss Margaret C. Eppler, *Clerk.*
›mology.	Fred C. Sears, M.Sc., *Professor.* Jacob K. Shaw, Ph.D., *Research Professor.* John S. Bailey, M.Sc., *Assistant Research Professor.*[3] Walter L. Cutler, *Laboratory Assistant.* Ray G. Smiley, B.Sc., *Investigator.*[4] Miss Ethelyn Streeter, *Stenographer.*
›ultry Husbandry.	John C. Graham, B.Sc., *Professor.* Frank A. Hays, Ph.D., *Research Professor.* Miss Ruby Sanborn, A.B., *Investigator.* Miss Esther M. Post, *Clerk.*
ıral Engineering.	Christian I. Gunness, B.Sc., *Professor.*
·terinary Science ıd Animal ıthology.	G. Edward Gage, Ph.D., *Professor.* Norman J. Pyle, V.M.D., *Assistant Research Professor of Avian Pathology.* Harold F. Rowley, B.Sc., *Technical Assistant.*

[1] Began work January 1, 1927. [2] Deceased. [3] On leave. [4] Temporary.

CONTROL SERVICE.

ENRI D. Haskins, B.Sc., *Official Chemist, Fertilizer Control.*
HILIP H. Smith, M.Sc., *Official Chemist, Feed Control.*
WELL S. Walker, B.Sc., *Assistant Official Chemist, Fertilizer Control.*
RANK J. Kokoski, B.Sc., *Analyst, Feed and Fertilizer Control.*
. W. Goodwin, B.Sc., *Analyst, Feed and Fertilizer Control.*
REDERICK A. McLaughlin, B.Sc., *Microscopist, Feed Control.*
MES T. Howard, *Inspector, Feed and Fertilizer Control.*
ISS Cora B. Grover, *Stenographer, Feed and Fertilizer Control.*
ENRY Van Roekel, M.S., D.V.M., *Specialist, Poultry Disease Elimination.*
LIFTON B. Waite, *Field Agent, Poultry Disease Elimination.*
RS. Leila Prescott, *Analyst, Poultry Disease Elimination.*
ISS Rebecca L. Mellor, *Clerk, Poultry Disease Elimination.*

REPORT OF THE DIRECTOR.

Sidney B. Haskell.

Organization under the Purnell Fund.

Since my last report the resources of the Station have been increased by the passage of the national Purnell act. This brings to the Station additional Federal appropriation, commencing at $20,000 annually in 1925, and increasing yearly until a total of $60,000 is expected to be reached in 1929. The Station is now in the middle of its second year under the Purnell fund appropriation.

As with other government funds, expenditures can be made only on the basis of project approved at Washington. In certain of their aspects these problems are of regional nature, in which the Station coöperates with other experiment stations in fulfilling the purposes of the Purnell act.

While the bill authorizing the appropriation of funds is somewhat general, yet it specifically contemplated three lines of work to be carried out under this fund: namely, in agricultural economics, in farm management, and in home economics. Following the provisions of the bill, therefore, the efforts of the Station have been intensified in these three lines.

The first outstanding product of the Purnell act in the field of agricultural economics was in participation by the Station in the New England-wide survey of the New England orchard industry. This gives to actual and potential orchardists means of estimating production in years to come. It gives the industry an opportunity had by no other similar industry to anticipate a constantly growing market program. It shows what may be done by well thought out economic research for the guidance of agricultural industries.

Work in farm management was not formally organized until the very end of the year (1926), although it was projected a year earlier. This contemplates detailed study of the competitive position of the more important farm enterprises of Massachusetts. It is expected that this work will be valuable in two directions: first, in giving our growers certain standards of efficiency to which they must approximate if they are to meet the competition of these other regions; and second, in giving our educational forces a body of data on which to base their work. In times past lack of such fundamental data has been responsible for much poorly directed effort.

Research studies in home economics were instituted in the fall and winter of 1925 and 1926. The subject chosen was "Food Consumption of School Children in Relation to Health." This was frankly a survey study, designed to determine the facts in the field, and to find where, if at all, the research service of the Station may be of service to Massachusetts country life. For the purpose of making the study the College loaned to the Station the services of Miss Helen Knowlton, Assistant Professor of Home Economics. She gave good service. On account of difficulties in filling the place permanently, it was not possible to effect final organization until toward the end of 1926.

Work of a different nature has been instituted in the departments of horticultural manufactures and of dairy manufactures. The central thought in both has to do with food conservation, partly through prevention of waste, partly through manufacture, and finally through relieving market glut by enabling producers to remove a part of their product to be manufactured and placed on the market at other seasons. In the department of dairy manufactures there is the added objective of developing ways and means through which manipulation of dairy products in milk-handling depots, creameries and ice-cream plants may be made more efficient and kept under better control.

To a very small degree increased resources due to the Purnell Fund have been used in supporting existing projects, particularly those in the department of poultry husbandry. In the genetics work of this department data have been accumulating beyond the ability of the available force of the Station to analyze and adjust. For this reason a small apportionment was made to the department, by means of which this work is being cleared up.

Organization of the Market Garden Field Station.

ǐince my last report the research staff at the Market Garden Field Station has ŋn completed. This now consists of a plant physiologist, a plant pathologist l an entomologist. The last two also give service to the orchard industry, l for this reason are assigned to the Field Station from the home offices, rather ɹn having direct membership in the Field Station staff. To all intents and ·poses, however, they represent a part of the scientific manpower mobilized in ı eastern part of the State, to assist in solving those problems which handicap · market gardening and vegetable growing industry.

[he advance made in the research study of many vital problems since the transfer the plant from Lexington to Waltham abundantly justifies the wisdom of the ıstees in making this transfer, and in securing from the Legislature appropriation the purpose.

Rebuilding the Cranberry Station.

[he building at the Cranberry Station was destroyed by fire on the night of ıy 30, 1926. All equipment was lost. Fortunately all records and reports :e in a fire-proof safe, which went through the fire without damage to the interior. addition to the loss to the Station was the loss of personal equipment used in ı Station service and owned by the superintendent of the Station, Dr. H. J. ınklin, by Mr. Lacroix, by Dr. N. E. Stevens, detailed by the United States partment of Agriculture, and by the Cape Cod Cranberry Association.

n rebuilding, the Station profited by the experience of the past dozen years, l now has a laboratory better suited to the needs of the Station. The new ldings are of cement, with garage separate from the main building. There is re laboratory space, and better toilet facilities than in the building which was troyed.

vice of the Cranberry Station.

he service of the Cranberry Station continues to be appreciated. The frost nings, developed by Dr. Franklin as a result of intensive study of meteorological nomena, have come to be widely utilized, with the distribution of the warnings he expense of the growers. The fact that most of the insect enemies attacking cranberry bog are now under control in one way or another goes back to the ny successful entomological studies conducted in the past twelve years by Dr. nklin. It is expected that the results of these studies will be shortly brought ether in a comprehensive bulletin.

Development of Station Land.

am glad to be able to report continued progress in the development of the oks Farm, purchased through funds appropriated by the Legislature in 1922, experimental purposes. The first objectives of this purchase, namely the study ertain problems connected with tobacco and with onion culture, are in a fair of being attained.

n tobacco, by agreement with the Connecticut Agricultural Experiment Station ch also carries on research with this crop, the Massachusetts Station is taking ts special field the problem of soil inhabiting diseases as influenced by management practices followed. The whole promises to give a contribution, not alone to cal industry of considerable importance, but to a better understanding of certain damental principles of soil fertility.

)wing to lack of funds the special work with onions was not started until the ing of 1925. The main item in the research program for this industry has to do h finding and improving that source of seed which will give to Massachusetts ducers the best possibility of competing with other regions. In addition a siderable area is laid out to comparative experiments with lime and with fertirs. These investigations will become more valuable with every passing year.

n both phases of the work the Experiment Station has the benefit of coöperation l advice from committees of growers, respectively Advisory Committee on bacco and Advisory Committee on Onions. The thanks of the Station are due he members of these committees, for the care and thought which they give to problems relating to their particular industries, and the oversight which they e to the development of a sound research program.

he equipment at the Tillson Farm has been greatly improved by the addition of the cottage for the plant foreman, with laboratory quarters for staff members. With this equipment the farm is now being used in the service of four departments: poultry husbandry having the first call on land facilities; the department of botany with station administration making certain studies in the pastures; the department of botany carrying on certain of its tobacco disease studies on the area; and finally, the department of pomology conducting its study on hardiness in peaches.

One more piece of major equipment is needed, a combined grain storage and root cellar, to make the farm more nearly self-supporting. When this is built, little more in the way of expensive equipment or apparatus will be needed.

The Station Research Program.

The catalog of active projects of the Experiment Station represents the research program as it is at any given moment. Rarely can such a program represent a well-rounded effort to meet all of the research needs of any agricultural industry of the State. Recognition must always be given to research being carried on in other states; problems of finance and of personnel may prevent certain necessary projects from being undertaken. The time factor in carrying out the several projects often prevents institution of new work. It goes without saying, however, that through the aid of advisory committees of farmers and of staff committees, the attempt is being made at all times to keep our research programs in line with existing need.

Catalog of Active Projects, December 1, 1926.

Agricultural Economics.

9. Study of taxation of farm property. Assistant Research Professor H. W. Yount. The work on this project is nearly completed, and the results will soon be published.

10b. A study of the performance of different varieties of apples, and market value of product. Assistant Research Professor L. P. Jefferson. Carried on in coöperation with a number of growers in different parts of the State. The growers have agreed to lay before the Station harvesting and marketing records to be secured over the next few years.

10c. The consumer demand for apples. Assistant Research Professor L. P. Jefferson. Contemplates a detailed study of sales and sales resistance both within and without the State.

11. A study of the supply and market distribution of Massachusetts poultry products. Assistant Research Professor H. W. Yount.

12. A study of the prices of eggs and poultry in Massachusetts. Assistant Professor D. W. Sawtelle and Assistant Research Professor H. W. Yount.

The preceding projects overlap somewhat. They recognize the fact of serious competition between New England poultry products and those imported from other sections, and are designed to give a basis for the sound competitive development of the Massachusetts industry.

Agricultural Engineering.

1. Investigation of apple storage houses. Professor C. I. Gunness. Data in support of this project are being taken in coöperation with operators of orchard storehouses in different parts of the State.

2. Refrigerating and mechanical factors involved in freezing ice-cream. Professor C. I. Gunness.

Agronomy.

2. Tobacco cropping system investigation. Research Professor J. P. Jones. The most marked result secured to date has been that of establishing the superiority of continuous cropping of tobacco over rotation cropping. In this respect Massachusetts results differ from those which have been reported from other tobacco sections. Since, as a matter of convenience in meeting existing market demand, Massachusetts growers find it necessary to shift from one crop to another fairly frequently, it will be advantageous if methods may be found whereby rotation cropping rather than continuous cropping may be developed.

2a. Accessory tobacco rotation plots. Research Professor J. P. Jones.

4. Study of residual effects of fertilizers. Research Professor J. P. Jones.

5. A field study of tobacco production in Massachusetts. Professor A. B. Beaumont. Represents a survey study of tobacco production in Massachusetts.

ginally it was expected that records would be taken for three or more years. lay in sorting and curing the tobacco has made this impossible, and raised stion as to whether the method is entirely sound. The project will be discontinued in another year.

'b. Investigation of the rôle of organic matter in the production of onions. t II, field work. Research Professor J. P. Jones. Attempts to maintain the ply of organic matter by the use of different cover crops. To date the most rked result is the raising of question as to the necessity of any particular provision the maintenance of organic matter in continuously cropped, heavily fertilized on soils.

. Study of the growth of onions as influenced by differential liming. Research fessor J. P. Jones.

. Effect of varying the ratio, amount and concentration of plant nutrients lied in onion growing. Research Professor J. P. Jones.

1. Study of the effect of crops plus their specific fertilizers upon those which ow, with special reference to tobacco. Research Professor J. P. Jones. Supnents Agronomy 2, and is designed primarily to determine the influence of erent previous crops on the tobacco crop.

5. A study of the relative efficiency of "based" and "unbased" sulfate of monia as carriers of nitrogen. Professor A. B. Beaumont.

6. Study of the relation of inorganic and organic toxins to brown root-rot of acco. Research Professor J. P. Jones.

7. The nitrogen intake of Havana tobacco. Professor A. B. Beaumont.

8. Onion breeding work. Research Professor J. P. Jones. Owing to the fact t very little onion seed is now raised in Massachusetts, growers are finding rer control over varieties and seed sources than was formerly the case. The tion is attempting to determine the factors which lead to good type of a storable ket onion.

9. The determination of the influence of varying the quantity of fertilizer ogen on the yield and quality of Havana tobacco when topped at different ghts. Research Professor J. P. Jones.

0. Testing onion sets and seed in the greenhouse. Research Professor J. P. es. By means of testing in the greenhouse it was hoped to get advance measureits of seed and set potency in the growing of onions. To date the attempt been unsuccessful.

any.

. Investigation of black root-rot of tobacco. Research Professor W. L. Doran. ults thus far secured are reported in Bulletin 229, "Soil Reaction and Black t-Rot of Tobacco."

. Investigation of a carrot blight. Assistant Research Professor E. L. Guba. ried out in coöperation with the Market Garden Field Station at Waltham, practically ready for publication.

3. Ecological study of pasture vegetation. Director S. B. Haskell and Professor V. Osmun. A brief progress report is printed in Bulletin 230, under the title tter Feed from Permanent Pastures."

8. Control of diseases of greenhouse vegetables. Research Professor W. L. an.

3a. Investigation of downy mildews of cucumber and lettuce. Research essor W. L. Doran.

). Investigation of tobacco brown root-rot. Research Professor W. L. Doran. nplementary to Agronomy 16, mentioned above. It represents one of three rse lines of attack on that problem.

l. Investigation of the use of chemicals for eradication of nematodes and para- fungi in greenhouse soils. Assistant Research Professor L. H. Jones.

it and Animal Chemistry.

Record of the Station herd. Professor J. B. Lindsey and Assistant Research essor J. G. Archibald. Consists in the routine measurement of feed consumed milk produced. The work has now been carried on for thirty-one years.

t. A study of the availability of soil potash with the object of developing a em of diagnosis for soils of the State. Research Professor F. W. Morse.

'. Investigation of the rôle of physical condition in artificial feeds for calves.

Professor J. B. Lindsey and Assistant Research Professor J. G. Archibald. Resul[ts] have been published in Bulletin 223, "Milk Substitutes in the Rearing of Youn[g] Calves," and in the article "Skim Milk Powders in the Rearing of Young Calves[,"] in Bulletin 230. Owing to the increasing sale of milk in a fluid form, it has bee[n] difficult for Massachusetts dairymen to raise replacement stock; and on accou[nt] of quarantine restrictions it has also been difficult safely to purchase such stoc[k.] This project, therefore, was instituted as part of a study to develop ways and mea[ns] of meeting the situation. The appearance on the market of artificially dried ski[m] milk of various kinds gives a satisfactory source of food which may meet the nee[d.]

19. The value of inorganic calcium phosphate in the promotion of growth an[d] milk production. Professor J. B. Lindsey and Assistant Research Professor J. G. Archibald. Results to date reported in the article "Mineral Matter for Dai[ry] Cows" in Bulletin 230; and in Scientific Contribution 46, "The Value of Calciu[m] Phosphate as a Supplement to the Ration of Dairy Cows."

20. A study of the fundamental factors affecting adhesiveness, toxicity, an[d] general efficiency of copper fungicides. Research Professor E. B. Holland. [A] partial report has been printed in Scientific Contribution 52, "The Preparatio[n] and Effectiveness of Basic Copper Sulphates for Fungicidal Purposes."

21. Study of nitrogen fixation in the presence of, or as the result of, growth [of] legumes versus non-legumes under certain defined agronomic conditions. Re[-]search Professor F. W. Morse. Carried on in coördination with Microbiology [.] Some of the old fertilizer experiment plots of the Experiment Station, which have ha[d] no fertilizer or other applied nitrogen for forty years, are being used in the stud[y.]

24. Chemical changes which occur in the cranberry during ripening and aft[er] harvesting. Research Professor F. W. Morse.

25. Studying the mineral requirements for the growth of dairy heifers. Profess[or] J. B. Lindsey and Assistant Research Professor J. G. Archibald.

Cranberry.

1. Injurious and beneficial insects affecting the cranberry. Research Profess[or] H. J. Franklin. One insect has been reported in Scientific Contribution 4[.] "The Life History and Control of the Cranberry Weevil, Anthonomus Musculu[s] Say (Coleoptera: Curculionidae.)

2. Cranberry disease work. (In coöperation with the Bureau of Plant Industr[y,] United States Department of Agriculture.) Research Professor H. J. Frankli[n.]

3. Weather observations with reference to frost protection. (In coöperatio[n] with the Weather Bureau of the United States.) Research Professor H. J. Frankli[n.] Frost warnings are sent out in the spring and fall at critical times, at the expens[e] of the growers. This represents an effective application of a difficult researc[h] study in meteorology.

5. Blueberry investigations. Research Professor H. J. Franklin.

Dairy Manufactures.

2. A study of washing powders for dairy use. Assistant Research Profess[or] A. W. Phillips.

3. The quinhydrone electrode in the dairy laboratory. Assistant Researc[h] Professor A. W. Phillips.

Entomology.

10. Dates of hatching of scale insects and when to spray for them. Assista[nt] Research Professor A. I. Bourne.

12. Determination of best strength of lime-sulfur. Assistant Research Professo[r] A. I. Bourne. Progress report, "Tests of Lime-Sulfur Solution and Some of It[s] Substitutes against San Jose Scale," printed in Bulletin 226.

16. Investigation of materials which promise value in insect control. Assistan[t] Research Professor A. I. Bourne.

17. Control of onion thrips. Assistant Research Professor A. I. Bourne. Prog[-]ress report, "A Study of the Life History and Control of the Onion Thrips,["] in Bulletin 227. Field work on the control of onion thrips has been complete[d] with development of a spray which, applied properly, gives control. Unfortu[-]nately, up to the time of writing, no machine has been developed capable of sprayin[g] under high pressure on closely planted rows such as we have in the onion fields[.] This project is being carried until such time as the proper machine becomes avail[-]able, or can be developed.

18. Adaptation of the recommended spray schedule for the control of orchard ects to Eastern Massachusetts conditions. Assistant Research Professor W. D. iitcomb.

19. Control of plum curculio in apples. Assistant Research Professor W. D. iitcomb.

rm Management.

2a. A study of competitive status of Massachusetts farm enterprises. R. L. ghell.

tilizer Control.

. To study the availability of the nitrogen contained in several processed anic ammoniates and other products for which a high availability is claimed. ofessor H. D. Haskins.

unds.

.. Demonstration experiment — lawns, lawn grasses, and lawn management. sistant Professor L. S. Dickinson.

me Economics.

.. Food consumption of school children in relation to health. Assistant Professor S. Davies. A survey study carried on in three rural towns, with the coöperation he schools and of the State Department of Health.

rticultural Manufactures.

.. The extraction of fruit juices in the manufacture of fruit jellies. Research ofessor C. R. Fellers.

2. Manufacture and preservation of cranberry products. Research Professor R. Fellers.

3. Utilization of onions by canning. Research Professor C. R. Fellers.

rket Garden Field Station.

. Study of the factors influencing heading of greenhouse lettuce. Assistant search Professor V. A. Tiedjens. A report of one phase of this study was nted as Scientific Contribution No. 31, "Stimulation of Plant Growth by Means Electric Lighting."

3. Study of conditions affecting the production and vegetative propagation of aragus. Assistant Research Professor V. A. Tiedjens. Some of the results this study are reported in Scientific Contribution 36, "Some Physiological oects of Asparagus Officinalis." Supplements the earlier work of the Experiment tion in coöperation with the United States Department of agriculture in breeding rust-resistant Washington asparagus. It was found that this asparagus, nough of very high quality, was quite variable between hill and hill, which gave to the attempt to propagate vegetatively and thus retain the best produced by d. Encouraging progress has been made, although the method is not yet dy for general distribution.

). Investigation of susceptibility to corn borer attack of varieties of sweet corn influenced by time of planting. P. W. Dempsey. Carried on on the basis a five-year program and financed coöperatively by the Corn Borer Laboratory Arlington, supported by the United States Government, and the Market Garden ld Station. Marked differences in susceptibility to attack are associated h time of planting; but thus far injury-free dates have not been established.

0. Variety improvement through seed and root selection: (a) The improvement beets (*Beta vulgaris*) through selection of roots and seed production; (b) The provement of carrots (*Daucus carota*) through selection of roots and seed production. Assistant Research Professor V. A. Tiedjens.

1. Control of red spiders on cucumbers in greenhouses. Assistant Research fessor W. D. Whitcomb. Merged with the project immediately following, ng to the fact that both insect and disease have to be cared for in a single spray dusting.

1a. Control of greenhouse red spider and powdery mildew of cucumbers by ombination spray. Assistant Research Professor W. D. Whitcomb and Assistant earch Professor E. F. Guba.

2. Biology and control of garden cutworms. Assistant Research Professor D. Whitcomb.

3. The genetics of greenhouse cucumbers in relation to shape, size, color and

set of fruit. Assistant Research Professor V. A. Tiedjens. A preliminary re rt was published as Bulletin 225, "Yellow Pickle in Greenhouse Cucumbers."

14. Cold resistance in sweet corn in its relation to quality, size and earlir ss. Assistant Research Professor V. A. Tiedjens.

15. The control of eggplant wilt caused by *Verticillium albo-atrum* R and B. Assistant Research Professor E. F. Guba.

Microbiology.

4. Addition to "Study of nitrogen fixation in the presence of, or as the resul of, growth of legumes versus non-legumes under certain defined agronomic conditi s. Assistant Research Professor L. A. Bradley.

Pomology.

1. Study of interrelation of stock and scion in apples. Research Professor J K. Shaw. Progress report, "Effect of Stock on Scion," in Bulletin 226. Pro ct started in 1912, on the basis of a twenty-year program. As the orchards were et out on leased land, it must come to maturity before 1932. Significant differe es in the interrelation of stock and scion have been shown.

2. A study of the tree characters of fruit varieties. Research Professor J K. Shaw. Supplements the project on Leaf Characters of Apple Varieties whic is the basis of present work in nursery certification.

3. The genetic composition of peaches. Research Professor J. K. Shaw. Sc n-tific Contribution 40, "Autumn Development of Peach Fruit Buds," is a re rt on certain studies made in connection with this project.

5. Comparison of cultivation and sod mulch in a bearing orchard. Rese h Professor J. K. Shaw. Scientific Contribution 39, "Sod-Nitrate vs. Cultiva n in Apple Orchard." Trees in nitrated sod mulch have made better growth d given larger yields than trees under cultivation. Results differ from those sec d in other sections, but apparently are fairly typical of much of the orchard a of southern New England.

8. Test of cover crops for apple orchards. Research Professor J. K. Shaw.

9. Testing methods of pruning. Research Professor J. K. Shaw. Prog ss report in Bulletin 226, "Pruning Young Apple Trees."

12. Apple variety fruit spur study. Research Professor J. K. Shaw and As t-ant Research Professor C. P. Jones.

13. A study of varieties of tree fruits. Research Professor J. K. Shaw. A routine project, consisting of the taking of many records on some thousand of fruit trees annually, these being available for classification in terms of vari y, soil, fertility treatment, management, etc.

14. Study of the relation of winter injury of brambles to differential fertiliza n with potash salts. Research Professor J. K. Shaw, Assistant Research Profe r C. P. Jones and Professor A. V. Osmun.

16. Test of different amounts of nitrate of soda. Research Professor J. K. Sh v.

17. A study of the cultivation of the high bush cranberry. (*Viburnum opul*). Research Professor J. K. Shaw.

18. Comparison of cultivation and heavy mulching for apples and pears. Rese h Professor J. K. Shaw. Heavy mulching with material brought into the orch d has produced a growth typical of a plentiful nitrogen supply. Chemical anal is has shown enormous production of nitrates beneath the mulch.

19. A study of the effects of fertilizer limitation on fruit plants. Resea h Professor J. K. Shaw. Scientific Contribution 38, "Some Unusual Results n Fertilizing Fruit Plants." Carried on on the old North Soil Test, full rep s of which were published in Bulletin 212. The trees have a staged condition brou t about by many years of differential fertilization. Differences in growth e enormous.

Poultry Husbandry.

1. Broodiness in poultry. Research Professor F. A. Hays. Technical Bull n 7, "Broodiness in Relation to Fecundity in the Domestic Fowl."

2. Breeding poultry for egg production. Research Professor F. A. H s. Scientific Contribution 30, "The Application of Genetic Principles in Breed g Poultry for Egg Production"; also Bulletins 211 and 215, published several ye s ago.

2a. Statistical study of heredity in Rhode Island Red breed of poultry. Rch Professor F. A. Hays. Technical Bulletins 8, "Winter Cycle and Winter se in Relation to Winter and Annual Egg Production" and 9, "Annual Perncy in Relation to Winter and Annual Egg Production; also Bulletin 220 lished several years ago.

. A genetic study of Rhode Island Red color. Research Professor F. A. Hays. ntific Contribution 43, "Inheritance of Plumage Color in the Rhode Island . Breed of Domestic Fowl."

. Determination of genetic laws governing results in inbreeding of poultry. earch Professor F. A. Hays.

. The hatchability of eggs. Research Professor F. A. Hays. Manuscript in press; also Technical Bulletin 6, published several years ago.

rinary Science.

. The standardization of avian diphtheria, roup, or bird pox virus and vaccines 1 special reference to improving the treatment of the disease. Assistant earch Professor N. J. Pyle.

. Ascertaining what percentage of pullets in a breeding flock should be laying re blood should be tested for indications of bacillary white diarrhoea infection. fessor G. E. Gage and H. Van Roekel. Project carried on by the Poultry ease Control Service, in response to evidence from the field indicating decreased ctiveness of the test when applied too early in the life of the pullet flock.

PROJECTS COMPLETED OR DISCONTINUED.

icultural Economics.

. Boston food supply study. Research Professor R. J. McFall. Completed, yet published.

a. The determination of amount of food products received in the New England suming area. Research Professor R. J. McFall. Completed, manuscript nitted.

. Study of the costs of marketing apples. Assistant Research Professor L. P. erson. Completed, results published in Bulletin 224, "The Cost of Marketing Apple Crop of 1923."

). Economic factors underlying the supply and market distribution of New land apples. Assistant Research Professor L. P. Jefferson, Completed, lts published in Bulletin 226, article entitled "The Apple Situation"; and letin 228, "An Economic Study of the Massachusetts Apple Industry."

)a. Study of the market outlets for Massachusetts (and New England) apples. stant Research Professor L. P. Jefferson. Completed, manuscript nearly ly for publication.

3. Study of the competitive factors influencing the supply of market milk and m in Massachusetts. Research Professor R. J. McFall. Discontinued, uscript being prepared for publication as a bulletin.

onomy.

Investigation of the value of Hubam or annual sweet clover as compared to biennial clovers. Assistant Professor C. A. Michels. Discontinued as a ion project.

Soil fertility studies on the South Soil Test. Research Professor J. P. Jones. ontinued on account of unavoidable disturbance from surrounding buildings.

Test of meadow fescue versus timothy under varying drainage conditions. essor A. B. Beaumont. Discontinued on account of soil variation being overed.

. Investigation of the rôle of organic matter in the production of onions. I. Pot work with soils deficient in organic matter. O. E. Street. Disinued as methods were found unsatisfactory.

). Effect of fractional application of fertilizer materials on growth, maturity quality of onions. Research Professor J. P. Jones. Combined with Project 9.

. Study of relationship of soil moisture content to yield and quality of tobacco. earch Professor J. P. Jones. Discontinued, methods unsatisfactory.

. Examination of the influence of source of seed in onion production. O. E. et. Combined with Project 18.

. The determination of the influence of certain nitrogenous fertilizer materials he yield and quality of Havana tobacco. Research Professor J. P. Jones. laced by Project 19.

Botany.

1. Optimum conditions of light for plant response. Assistant Professor C. L. Clark. Discontinued on account of resignation of Professor Clark from the Station staff.

5. Experimental spraying for control of cucumber mildew under glass. Professor A. V. Osmun. Merged with Project 18.

6. Investigation of onion diseases. Professor A. V. Osmun. Completed. Results reported in Technical Bulletin 4, "Development and Pathogenesis of the Onion Smut Fungus"; Bulletin 221, "The Smut Disease of Onions"; Scientific Contributions 4, "An Improved Formaldehyde Tank for the Onion Drill"; 5, "The Relation of Soil Moisture to Formaldehyde Injury of Onion Seedlings"; 32, "Controlling Onion Smut with Kalimat"; 42, Comparative Susceptibility of Onion Varieties and of Species of Allium to Urocystis Cepulae"; Bulletin [illegible]7, article entitled "Onion Blight or Downy Mildew."

14. Investigation on control of tobacco wildfire. Research Professor P. J. Anderson. Completed, results reported in Bulletins 203, "Tobacco Wildfire—Preliminary Report of Investigations"; 213, "Tobacco Wildfire in 1922"; Scientific Contributions 27, "Overwintering of Tobacco Wildfire Bacteria in New England"; and 33, "Susceptibility of Nicotiana Species, Varieties and Hybrids to Tobacco Wildfire."

16. Relation of soil character to occurrence of onion smut. Research Professor P. J. Anderson. Completed. For reports, see bulletins and articles listed under Project 6.

17. Study of apple black rot control and the dusting schedule. Research Professor W. L. Doran. Completed, results published in Bulletin 222, "Experiments on the Control of Apple Scab and Black Rot and Spray Injury in 19[illegible]."

20. Investigation of nematode eradication in greenhouse soils by the use of calcium cyanide. (In coöperation with American Cyanamid Company.) Assistant Research Professor L. H. Jones. Superseded by Project 21.

Plant and Animal Chemistry.

22. Determining the nutritive value of hydrolized sawdust. Professor J. B. Lindsey and Assistant Research Professor J. G. Archibald. Completed, results published in Scientific Contribution 48, "The Composition, Digestibility and Feeding Value of Hydrolized Sawdust."

23. Study of coloring matter in cranberries. Research Professor F. W. Morse. Manuscript submitted for publication.

Cranberry.

6. Cranberry bud development investigation. D. S. Lacroix. Completed. Results published in Scientific Contribution 50, "Cranberry Flower-Bud Investigations."

Dairy Manufactures.

1. Determining factors influencing volume weight in ice-cream. Assistant Research Professor A. W. Phillips. Completed, manuscript submitted.

Entomology.

4. Control of squash vine borer. Assistant Professor H. N. Worthley. Completed, results published in Bulletin 218, "The Control of the Squash Vine Borer in Massachusetts."

5. Control of the squash bug. Assistant Professor H. N. Worthley. Discontinued. Reports published in Scientific Contributions 7, "The Squash Bug in Massachusetts (*Anasa tristis* De Geer) with Notes on the Parasite *Trichopoda pennipes* (Dipt., Tach.)"; 19, "The Biology of *Trichopoda pennipes* Fab. (Diptera, Tachinidae), a Parasite of the Common Squash Bug."

9. Number of generations of codling moth in Massachusetts and whether spraying for a second generation is advisable. Assistant Research Professor A. I. Bourne. Completed, manuscript nearly ready for publication.

13. Study of possible injurious effects of Scalecide on trees. Assistant Research Professor A. I. Bourne. Preliminary report in Bulletin 226, entitled "Some Results from Spraying with Scalecide"; final report being prepared.

14. Does spraying orchards kill bees? Assistant Research Professor A. I. Bourne. Completed, manuscript nearly ready for publication.

;. A study of the factors influencing the efficiency of nicotine in dusts and spray tures. Assistant Professor H. N. Worthley. Discontinued on account of the gnation of Professor Worthley. Manuscript submitted.

n Management.

Investigation of farm organization and labor efficiency on Massachusetts ıs. Professor J. A. Foord. Discontinued.

robiology.

Soil fertility as influenced by micro-organisms in their relation to the presence disappearance of organic matter. Assistant Professor C. H. Werkman. ersedеd by Project 4. A report of some of the results was published as Scien- Contribution 37, "Biological Investigation of Peat."

ıology.

Test of fertilizers in a sod mulch orchard. Research Professor J. K. Shaw. continued on account of injury to orchard.

;. Orchard fertilization. Research Professor J. K. Shaw. Discontinued. port of the fertilizer studies in this orchard was published several years ago ulletin 209.

). Test of fertilizers for pears. Research Professor J. K. Shaw. Discontinued ccount of attack of blight.

. Study of fruit harvesting and storage. G. J. Raleigh. Completed, results ished in U. S. D. A. Department Bulletin 1406.

rinary Science.

The therapeutic efficiency of avian diphtheria, roup, or bird pox vaccines. stant Research Professor N. J. Pyle. Completed, results published in Technical etin 10, "The Therapeutic Efficiency of Avian Diphtheria, Roup, and Bird Vaccines and Bacterins."

Publications, 1925–1926.

uring the period covered by this report, and as a measure of economy which s also to efficiency in distribution of material, many of the reports of the ous projects have been published through technical and scientific journals, er than in the regular bulletin series of the Experiment Station. With the lopment of the Extension Service, the primary audience to which results of urch work in agricultural science are presented consists of teachers and ex- ion specialists rather than of actual farmers. It is believed that this change o way decreases the service of the Station to its main constituents, the ers of the State. Furthermore, the definite preparation of manuscript for stricted audience leads to more efficient preparation of manuscript than is ible when the audience consists of diverse groups. The following shows the ications of the years in question:

Annual Report.

iirty-seventh annual report with index.

Bulletins.

221. The Smut Disease of Onions, by P. J. Anderson and A. Vincent Osmun.
222. Experiments on the Control of Apple Scab and Black Rot and Spray Injury in 1924, by W. L. Doran.
223. Milk Substitutes in the Rearing of Young Calves, by J. B. Lindsey and J. G. Archibald.
224. The Costs of Marketing the Apple Crop of 1923, by Lorian P. Jefferson.
225. Yellow Pickle in Greenhouse Cucumbers, by Victor A. Tiedjens.
226. Research Service to the Massachusetts Apple Industry: Progress Reports, by Lorian P. Jefferson and Hubert W. Yount, J. K. Shaw, William Doran, J. S. Bailey and A. I. Bourne.
227. The Connecticut Valley Onion Industry: Progress Reports of Experimental Work, by Lorian P. Jefferson, A. B. Beaumont and O. E. Street, A. Vincent Osmun and A. I. Bourne.
228. An Economic Study of the Massachusetts Apple Industry, by Hubert W. Yount and Lorian P. Jefferson.

No. 229. Soil Reaction and Black Root-Rot of Tobacco, by P. J. Anders , Vincent Osmun and W. L. Doran.

No. 230. Research Service to Massachusetts Animal Industry: Progress Re by J. B. Lindsey, J. G. Archibald and Sidney B. Haskell.

Bulletins, Technical Series.

No. 7. Broodiness in Relation to Fecundity in the Domestic Fowl, by Hays and Ruby Sanborn.

No. 8. Winter Cycle and Winter Pause in Relation to Winter and Annua E Production, by F. A. Hays and Ruby Sanborn.

No. 9. Annual Persistency in Relation to Winter and Annual Egg Produ by F. A. Hays and Ruby Sanborn.

No. 10. The Therapeutic Efficiency of Avian Diphtheria, Roup, and Bir Vaccines and Bacterins, by Norman J. Pyle.

Bulletins, Control Series.

No. 31. Control of Bacillary White Diarrhoea, 1924–1925, by P. E. Bran

No. 32. Inspection of Commercial Feedstuffs (1925), by Philip H. Smit Frank J. Kokoski.

No. 33. Inspection of Commercial Fertilizers (1925), by H. D. Haskins, Walker and George B. Dalrymple.

No. 34. Inspection of Agricultural Lime Products (1925), by H. D. Ha L. S. Walker and G. B. Dalrymple.

No. 35. Control of Bacillary White Diarrhoea, 1925–1926, by P. E. Brar

No. 36. Inspection of Commercial Feedstuffs (1926), by Philip H. Smit Frank J. Kokoski.

No. 37. Inspection of Commercial Fertilizers (1926), by H. D. Haskins, Walker and M. W. Goodwin.

No. 38. Inspection of Lime Products Used in Agriculture (1926), by Haskins, L. S. Walker and M. W. Goodwin.

Meteorological Reports.

Nos. 433–456, inclusive.

Scientific Contributions.

No. 30. The Application of Genetic Principles in Breeding Poultry fo E Production, by F. A. Hays. In Poultry Sci. 4:43–50. 1924–25.

No. 32. Controlling Onion Smut with Kalimat, by P. J. Anderson. In pathology 14:569–574. 1924.

No. 33. Susceptibility of Nicotiana Species, Varieties and Hybrids to T Wildfire, by P. J. Anderson. In Phytopathology 15:77–84. 1 5.

No. 34. The Availability of Subsoil Potash, by Sidney B. Haskell. In Sc 19:105–114. 1925.

No. 35. Annual Crops from Biennial Bearing Apple Trees, by Brooks D. In Amer. Soc. Hort. Sci. Proc. 300–302. 1924.

No. 36. Some Physiological Aspects of Asparagus Officinalis, by Victor A. jens. In Amer. Soc. Hort. Sci. Proc. 129–140. 1924.

No. 37. Biological Investigation of Peat, by Arao Itano. In Jour. Bact. 95. 1925.

No. 38. Some Unusual Results in Fertilizing Fruit Plants, by J. K. Sha Amer. Soc. Hort. Sci. Proc. 281–286. 1924.

No. 39. Sod-Nitrate vs. Cultivation in the Apple Orchard, by J. K. Sha Amer. Soc. Hort. Sci. Proc. 328–337. 1924.

No. 40. Autumn Development of Peach Fruit Buds, by J. S. Bailey. In Soc. Hort. Sci. Proc. 30–33. 1924.

No. 41. The Economics of Fertilizer Use in the United States, by Sid Haskell. In Jour. Amer. Soc. Agron. 17:198–210. 1925.

No. 42. Comparative Susceptibility of Onion Varieties and of Species of to Urocystis Cepulae, by P. J. Anderson. In Jour. Agr. Re 31:275–286. 1925.

No. 43. Inheritance of Plumage Color in the Rhode Island Red Breed of Do Fowl, by F. A. Hays. In Genetics 11:355–371. 1926.

No. 44. The Digestibility and Energy Values of Feeds for Horses, by J. B. Li

C. L. Beals and J. G. Archibald. In Jour. Agr. Research 32:569–604. 1926.

45. Life History of Ustilago Striaeformis (Westd.) Niessl which Causes a Leaf Smut in Timothy, by W. H. Davis. In Jour. Agr. Research 32:69–75. 1926.
46. The Value of Calcium Phosphate as a Supplement to the Ration of Dairy Cows, by J. B. Lindsey and J. G. Archibald. In Jour. Agr. Research 31:771–791. 1925.
47. The Life History and Control of the Cranberry Weevil, Anthonomus Musculus Say (Coleoptera: Curculionidae), by Donald Sewall Lacroix. In Jour. Econ. Ent. 19:819–829. 1926.
48. The Composition, Digestibility and Feeding Value of Hydrolyzed Sawdust, by J. G. Archibald. In Jour. Dairy Sci. 9:251–271. 1926.
49. The Bacteriophage in Relation to Salmonella Pullora Infection in the Domestic Fowl, by Norman J. Pyle. In Jour. Bact. 12:245–260. 1926.
50. Cranberry Flower-Bud Investigations, by Donald Sewall Lacroix. In Jour. Agr. Research 33:355–363. 1926.
51. The Balance of Trade in Farm Products, by Lorian P. Jefferson. In Jour. Farm Econ. 8:451–461. 1926.
52. The Preparation and Effectiveness of Basic Copper Sulphates for Fungicidal Purposes, by E. B. Holland, C. O. Dunbar and G. M. Gilligan. In Jour. Agr. Research 33:741–751. 1926.

Control Activities of the Experiment Station.

ı addition to its main functions of a research agency, the Experiment Station ıinisters four control laws, namely, providing for chemical control of commercial stuffs sold within the State, and of commercial fertilizers and lime, providing the testing of poultry for bacillary white diarrhoea, and inspection of dairy sware. In the first three of these, which are the major control activities of Station, reports were published covering the operations of both 1925 and 1926. ;her comment on this phase of the work is not needed at this time.

ıcrease in knowledge regarding the properties of certain agricultural comities, and conditions governing their effective use, make necessary three changes isting control laws, as follows:

The great increase in the use of cod liver oil and other vitamin carriers, in ı animal and human nutrition, makes necessary a form of guarantee under :h they may be sold, different from any which has previously been in common ;e. Existing knowledge as to conditions governing vitamin potency does not 'ant hard-and-fast control such as is now exercised to a degree on ordinary mercial mill feeds. Without doubt, also, the United States Government a function in the matter, which may better be exercised than the authority dividual states. Until such time as the Government takes over this function exercises it in an effective way, purchasers are at the mercy of unscrupulous ufacturers and dealers. The principle involved should be that of the correct ing act, to the effect that whatever is claimed for the product sold should be ɔct to check by a neutral state-supported agency.

In the field of fertilizers and other products sold for the purpose of increasing productivity of the soil, there is now an array of inoculants which is giving ;o serious thought as to effective use. These are classified in two groups: first, lled legume inoculants, the use of which is fairly well established, but which is State are sold without examination by any neutral agency to check state-; made; and general inoculants, the use of which is not yet well established. e there have not yet been standard control methods worked out to govern ale of these products, yet the general application of a correct labeling principle ɔe fair to the manufacturer and give to our farmers and other users a degree otection which is sadly needed.

A more elastic financial system is needed in the administration of the poultry se law. This activity is now practically self-supporting. It is impossible, ver, to foresee the need in any given year. Our budgets, of necessity, are ; out practically a year before they become effective. I therefore suggest in administering this law the Trustees ask for a sum materially greater than allowed — $14,000 or $15,000 — and arrive at an understanding whereby expenditures above a certain minimum — possibly the present appropriat[n] $10,000 — be allowed only in so far as income is produced to match the inc[...] This plan, if allowed, will preserve the system of a fixed budget with respons[i...] to State authorities for expenditures, and at the same time introduce the pri[...] of a revolving fund.

Service Activities of the Station and Institution.

In addition to the formal research service, which represents the primary fu[...] of the Experiment Station, and the miscellaneous items of chemical and biol[...] control which are administered by the Station as a matter of convenienc[...] tradition rather than of logical organization, there is a mass of border-line work [...] for lack of a better term has been called "service." This includes participat[...] spray service for orchardists with reference to the time of applying sprays for c[...] of insect and disease; frost warnings issued from the Cranberry Station; dia[...] of poultry diseases, plant diseases and soil troubles; miscellaneous analytical [...] on products sent in for examination; supplying legume inoculants; chemic[...] bacteriological analysis of water and bacteriological examination of milk [...] ticipation on a small scale in potato seed certification and supplying neutral s[...] ists for orchard certification; and other similar services. In as far as is p[...] this work is done on a fee basis, it being expected that the fee will be suffic[...] large to meet actual costs. It is the hope of the station, furthermore, to disco[...] this service as rapidly as coöperative or commercial organizations develop s[...] make the service unnecessary. At the present time, however, the fact [...] service is a rather serious drain on research funds, and in at least one depa[...] has been carried on to such an extent as almost to inhibit successful prose[...] of fundamental research. In the opinion of the writer this work should [...] formally recognized status in the College, and should attempt to correlate [...] office all of such work regardless of where or under what division it may be do[...].

MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

lletin No. 221 December, 1924

HE SMUT DISEASE OF ONIONS

By P. J. Anderson and A. Vincent Osmun

This bulletin records six years' experiments on the control of smut, the most ructive disease of onions in New England and presents practical recommenda- s based on these experiments. It also includes an account of the origin, history economic importance of the disease and the development of the causal organism.

Requests for Bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION
AMHERST, MASS.

10 4-25 Order No. 817

THE SMUT DISEASE OF ONIONS

By P. J. Anderson and A. V. Osmun

INTRODUCTION

Commercial onion growing in Massachusetts sixty years ago was confined to the tern part of the state, centering especially in Essex county about the Danvers tion. But continuous cropping brought diminishing yields year by year until growers found that they could no longer produce a profitable return on onions n in that fertile section. New land must be found, and the industry shifted dually to the west until now practically all of the Massachusetts domestic supply urplus onions is produced in the Connecticut Valley. The fertile acres of the ivers section, famous onion center since colonial days, are no longer planted to ons.

When we inquire into the reasons for the diminishing crops and the westward ting of the industry we find that the most important contributing factor was the ease in the prevalence and destructiveness of smut until the toll which it took ed out the profits. A field once thoroughly infested with smut was permanently inated from profitable onion growing, and since no method of checking the ase had been discovered at that time, the inevitable result was the migration of industry from a section so largely planted to onions.

The Connecticut Valley region, however, did not long escape. Year by year, it became more prevalent; fields were being planted to other crops and the his- of Danvers was in a fair way to be repeated along the Connecticut, when the naldehyde method of controlling smut was discovered and the industry saved the Valley.

But the formaldehyde method as worked out by the pathologists of twenty years was far from satisfactory. The formulas of application which they recom- ded were cumbersome and the machinery inadequate. The writers were unable nd a single grower in the Connecticut Valley who was applying the formaldehyde rding to the rates of dilution and distribution which were recommended by the iologists. Finding these inconvenient, the practical growers modified them in ous ways to suit themselves. The results obtained were more various than the s of application. Some were successful; many had partial control; others ruined crop. Lack of uniformly successful results caused many to condemn the method either to plant the fields to less profitable crops or to omit the formaldehyde and the onion crop at a reduced profit or an actual loss.

uch was the situation when the writers began their investigation of onion smut 918. The whole field of control seemed ripe for a reworking.

t was necessary that a formula of applying the formaldehyde be determined and dardized for Connecticut Valley conditions, a formula which should be practical he grower and at the same time could be depended on to control the disease and cause serious injury to the onions. The machine for application must be im- ed. The behavior and life-history of the smut fungus throughout the whole must be carefully studied with the special object of finding a better method of bating the disease. Many other minor problems were yet unsolved.

During the last six years the investigation has been prosecuted in the laboratory greenhouse during the winter and in the fields of the onion growers of Sunder- , Amherst and Leverett and on the Experiment Station farm during the growing on. It was essential that the field control experiments be continued through a s of years on different farms because it was found that the season and other environmental conditions influenced the results of the treatment and it was desirable to develop a method which would be suitable for every year under a wide range of conditions. The writers believe that after six years of experimenting they are ready to publish definite recommendations. In the present bulletin there are also presented the experiments and data on which the recommendations are based, along with the results of some other accessory lines of investigation on onion smut.

HISTORY OF THE DISEASE

Onion smut is probably a disease of American origin, although its history previous to 1857 is unknown. Onions have been cultivated and used by all the civilized races of the world in all ages. Starting with the inscriptions on the pyramids, there is an enormous amount of ancient and modern literature on all phases of onions and onion culture, but it contains no mention of smut or any trouble which might be interpreted as smut previous to the middle of the 19th century, when it was first found in New England. If smut is of Old World origin, this omission is certainly nothing short of remarkable. Is it not more probable that it occurred in an inconspicuous way on some other closely related American plant and thence passed over to the onion which it found to be a more suitable host? To be sure, we have no published record of its occurrence on any other American plant (except for one record of a wild onion, *Allium Nevadense*, in the Far West); but when one recalls that new diseases and new hosts of disease organisms are being discovered every day, and that it may occur on its wild host plant only as an inconspicuous seedling disease, this does not seem to be a serious objection. The fact that the disease has been found on twenty-six other species of plants of the same genus not previously reported as affected by smut (p. 8) indicates that all of the host plants of the onion smut have not yet been found.

The first published record of the existence of onion smut which the writers have seen is in the Proceedings of the Essex Institute for 1857 (31: 207, 211–214)*.

Since this interesting article seems to have escaped the notice of other students of the disease† and is in a rather inaccessible publication we quote it in full. At a field meeting of the society at Beverly, Mass., on June 24, 1857, a letter was read by the secretary from Mr. J. W. Proctor,‡ a Danvers farmer. This letter according to the report of the secretary, Mr. Wheatland,

> "treated of the smut of the onion and of a maggot, which attacks that vegetable, threatening serious injury to the onion crops. He considered that at least half the estimated crop of the present season would be lost. This letter was referred to a committee consisting of Messrs. S. P. Fowler, George D. Phippin, and Henry F. King, in order that it might make the necessary investigation, and report on the subject at some subsequent meeting of the Society."

At the next meeting, which was held at Wenham on July 10, 1857, Mr. Geo. D. Phippin of Salem, made the following report on onion smut:

> "As to the second agency found so destructive in the cultivation of the onion, your committee report that the smut found growing in the leaves of the onion has been examined under the microscope; but the specimens used were so imperfect that no information of a decisive character has been obtained. It is evident that the smut of the onion is a parasitical fungus which originates and develops itself within the cellular tissues of the leaves looking in some stages of growth like the filaments of a Botrytis. It makes its appearance on the first leaf and descends toward the root destroying the texture and rendering the leaf spongy and streaked with black dust. Perhaps then it may originate from the use of too much putrescent

*Numbers in parenthesis refer to bibliography in the back of this bulletin. Numbers after the colon give the page on which statements referred to may be found.

†All the writers on onion smut who have mentioned the matter at all (Farlow, Thaxter, Stone, Selby, Cornu, *et al.*) quote as the first published record, the observation of Ware (51), 12 years later. Probably a more thorough search through the agricultural literature of Essex County just previous to 1857 would reveal earlier allusions to smut.

‡Ten years previous to this date Mr. Proctor, who appears to have been an onion grower of considerable prominence, presented "An Essay on the Cultivation of the Onion" before the Essex Agricultural Society (33) in which he gave considerable attention to the pests and enemies of the onion, but no mention is made of smut. The fact that a practical, keen observer like Mr. Proctor had never seen smut leads us to believe that it was not present at that early date in the Danvers section.

matter in the soil, helped toward development by a peculiar low and damp atmosphere. The use of muscle-bed mud for culture of onions is well known but we have not ascertained whether such manuring is liable to the fly or not. An overmanured soil made so by too much putrescent animal or vegetable matters could be treated with lime ashes or charcoal, which by helping to absorb the ammonia would check the fermentary process so favorable to the growing of fungi of every kind.

"It would be interesting to ascertain whether this particular species of smut is to be found upon the leaves of the wild garlic (*Allium canadense*) for it may be that a more succulent condition of the cultivated plant as in our field onion, may be more susceptible to this disease from the high culture which it obtains. Such parasitic plants destructive to crops, indicate the tendency toward extinction of a particular variety, and the remedy may lie in changing the seed or by inducing some newer form not liable to be thus affected."

The next published record of the disease is in the appendix of the 17th annual ort of the Massachusetts Board of Agriculture (51:10) in which is printed an lress by Mr. Benjamin P. Ware, a Marblehead farmer, before the Essex Agricul-al Society on September 29, 1869. He states that smut is "very destructive, ning the most promising fields . . . to scenes of desolation," and that it "so im-gnates the land with its spore as to render it unsafe to plant onions for several rs on land thus affected." In view of our present knowledge of the long time uired for impregnation of the land, these statements indicate that smut was not a v disease in Essex County in 1869, but that it must have existed for many years. ere is evidence according to Thaxter (44:131) that it occurred in Connecticut as ly as 1860, although there is no published record. In his report of the U. S. partment of Agriculture for 1869 (7:224) the commissioner, Mr. Horace Capron, otes a page to onion smut, but mentions no locality except Massachusetts. m this, one judges that it was not known to occur in other states at that time. the U. S. Commissioner's report for 1872, (43:193) Mr. Thomas Taylor, the roscopist, mentions a field of four acres in Swampscott where the disease was so that the field was abandoned. In the same report, he published the first figures nion smut spores. The first accurate scientific description of the disease and its sal fungus is by Farlow (14:164) in the appendix of the report of the Massachu-s Board of Agriculture for 1876. He states that at that time it was not known occur anywhere except in Massachusetts and Connecticut and presents convinc-evidence that it was of recent origin.

Summing up all the evidence in regard to the origin of smut we may say that in robability it existed on some native American plant closely related to the onion first made its appearance on the cultivated species about 1850 in New England. From New England it has spread to all of the onion-growing regions of the north-United States, but is not known to occur in the southern states. In 1889 it was wn to be present in Ohio and Pennsylvania (44:135) and in Vermont (25:141), v Jersey in 1890 (20:352), New York, previous to 1869 (37), Iowa, about 1900, 216) and reached the Pacific coast about 1911 (6:187). The date of introduc-into other states is not recorded, but at present it is known to occur in Indiana, ois, Wisconsin, Missouri, North Dakota, Delaware, Kentucky, Tennessee, West inia, Kansas and Minnesota.

t is probable that it spread from America to Europe and other parts of the d. It was reported from near Amiens, France, as early as 1872 (12:40), from hern France in 1877 (34:379) and from the neighborhood of Paris in 1879 51). It is said by Frank (17:186) to have been found the same year in Germany Leipzig, but Zillig (54:298) questions this since he finds the first official report s occurrence in Germany in 1909. If it occurred in Germany during the inter-ng years it must have been very inconspicuous. Zillig (1923) states that in country it sometimes causes a loss of 60 per cent of the crop. The first pub-d record of smut in England was in 1919 (13:168) but there is evidence that it rred in the British Isles as early as 1900 (52:443). Walker (49:15) reported it ommon in Holland. It has also been reported from Denmark. The writers also informed by Dr. Ito of the Sapporo Experiment station that it is not un-non in Japan. The losses from smut in countries other than America have not lly been considered serious.

LOSSES FROM SMUT

Onion smut has caused—and is now causing—great losses to the onion growers because:

1. Many acres of land best suited for the growing of onions have had to be turned to the growing of other crops because the land was so impregnated with smut that a good crop of onions could no longer be grown.
2. It costs just as much to tend a crop where smut has reduced the stand as it does to tend a full stand but the returns are less. The diminished yield frequently leaves no margin between cost of production and the selling price.
3. The price of chemical, special apparatus and extra labor for application of chemical, where preventive measures are used, must be added to the production cost.

The Plant Disease Survey of the United States Department of Agriculture (32:210) estimated the loss from this disease in the United States in 1918 at 754,000 bushels. In individual fields in Massachusetts losses may vary from 0 to nearly 100 per cent.

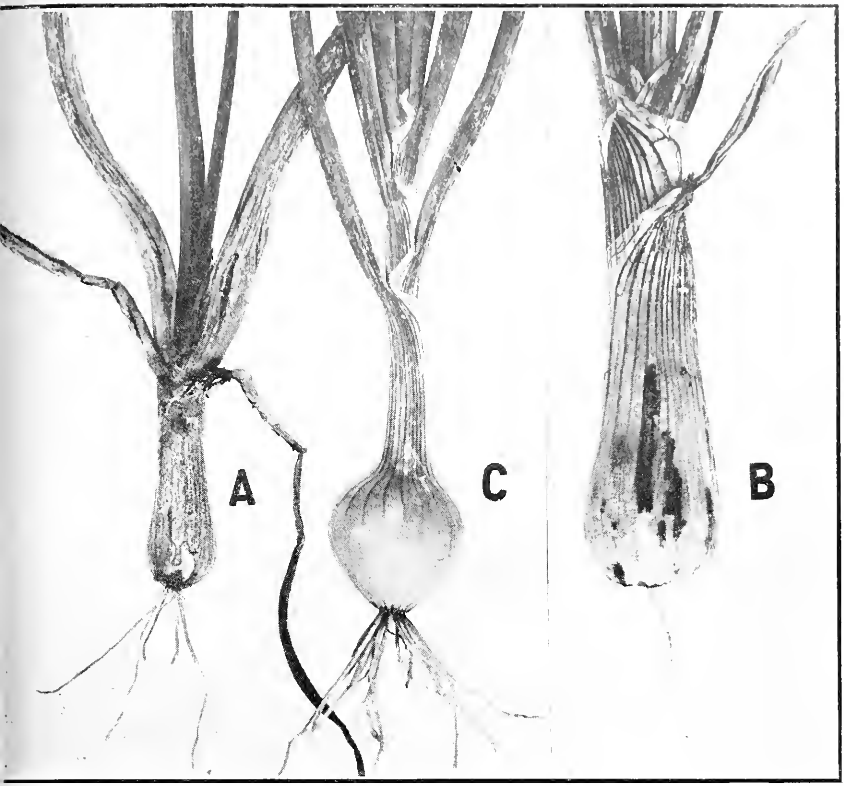
At attempt to calculate the losses in dollars would be conditioned by so many modifying factors that it would necessarily be the merest guess and no such attempt will be made by the writers. It is, by all odds, the most important disease of onions occurring in America, and time or money spent in controlling it is well worth while.

SYMPTOMS

The first signs of smut appear on the young seedlings within two or three weeks after the seed are planted. In fact, the very first recognizable indication of disease has been observed here (1:131) within ten days from the date of planting. The cotyledon (or seed leaf) which is the first part to appear above the ground is marked by a slight distortion and swelling instead of being perfectly straight as is the case with a healthy plant. A few days later, when one holds the plant up to the light and looks through it, he sees a dense black, opaque, elongated area (or several of such) inside the seed leaf. Many of these weakened plants "damp off" and fall at this stage. Even if they do not damp off they gradually shrivel and die if the attack is severe. If one crushes these dead cotyledons he finds them filled with a black powder (spores). The heaviest loss in an infested field is during this cotyledon stage; the grower notices that his rows become thinner day by day, until only a fraction of the seedlings which came up remain standing. If, however, the initial attack was not very severe the plants do not die in the cotyledon stage but the successive leaves develop and in many cases are perfectly healthy, the disease having been sloughed off with the cotyledon. But usually smut will appear as long dark streaks in each of the succeeding leaves. Such plants remain stunted and the leaves are short, brittle, and distorted (Fig. 1A). They continue to die in various stages of development throughout the summer. Very few of them develop bulbs of any size. Even if they continue to live until time of harvesting, they are never stored because in the last stages they develop "bottom rot" and are thrown out. As the diseased plants grow larger, the black smut pustules (or lesions) also increase in size. They may be several inches long or extend throughout the entire length of the leaf. As the leaf becomes old and dried these lesions split open and the spores fall out (Fig. 1A). Frequently they rupture to the inside of the hollow leaf. On the bulb itself, the pustules are raised and appear gray as one looks at the black mass through the white covering of the scales (Fig. 1B). When the outer scales die the black spores fall out into the soil (Fig. 1). The appearance of a row of diseased onions as compared with a row of healthy onions is shown in Fig. 2.

THE CAUSE OF SMUT

Smut is produced by the growth inside the tissues of the onion of a parasitic fungus of the order Ustilaginales. The spores of this fungus were first distinguished and figured by Taylor in 1872 (43:193 and Fig. 29), but the first accurate description is by W. G. Farlow of Harvard University in 1876 (14:175). C. C. Frost of Brattleboro, Vt., had previously examined it and found that it belonged to the smut genus



1.—Symptoms of smut on mature onions. A. Showing distorted leaves with ruptured pustules xposing black spore powder. B. Smut pustules on bulb. C. Healthy onion for comparison. lote failure of diseased plants to develop normal bulbs.

Fig. 2.—Formaldehyde treatment for smut. 2 rows in center received no formaldehyde.

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Shortly after Farlow described this as a new species there was considerable dission among students of fungi as to whether this really was a new species or ether it was identical with some previously described smut. No smut fungus been described previously from the cultivated onions but some had been cribed from wild species of the same genus and from closely related genera of the aceae. Thus *Urocystis magica* was described from Italy on *Allium magicum.* low, in his second paper (15:114) expresses the opinion that *U. cepulae* is identical h *U. magica* Pass. Another closely related smut is *U. Colchici* Schlecht which urs on *Allium rotundum* and a number of species of the Liliaceae outside the us Allium. Farlow pointed out the differences between *U. Colchici* and *U. ulae* and considered them as distinct. Cooke (9:634) however, considers the erence insufficient for specific rank and calls the onion fungus *U. Colchici var. ulae.* Magnus (28:348) also considered *U. cepulae* as distinct from *U. Colchici.* roeter and Winter (Die Pilze, p. 121, 1884) would unite all the above species er *U. Colchici.* Magnus and Cornu agree with Farlow in keeping the two dist. Clinton in his monograph of the North American Ustilagineae (8:451) says, here has been some discussion whether the American species is distinct from *cystis Colchici* and *Urocystis magica* of Europe, the latter species also occurring species of Allium. The three while very closely related are distinct. The ies described here (*U. cepulae*) differs from both in having smaller spores and e balls and also from *U. Colchici* by rarely having more than one spore in a ball." ther species of Urocystis on Allium is *U. Allii* (Belham) Schellenberg on *Allium hirsutum.* The writers have not examined this species, but both Liro and ellenburg regard it as distinct from *U. cepulae.* Inoculation experiments by erson showed *A. subhirsutum* to be one of the few species of Allium which are nune to *U. cepulae.*

Liro (27) has recently merged the genus Urocystis with the older genus Tubura because he was unable to distinguish any morphological differences between n and has proposed the name *Tuburcinia cepulae* (Fr.) Liro as the correct name the onion pathogene. This change has been adopted by European writers but et has not appeared in American literature. In both of these genera, the spore ore commonly called the "spore ball"—is not a single cell but is composed of a ose ball of a number of cells permanently bound together. In Tuburcinia all of e cells are fertile, *i.e.* capable of germination, while in Urocystis only the central are fertile while the peripheral ones are sterile and called accessory cells. In osition to this usual conception Liro maintains that no such distinction exists, that in all these species there is a covering layer of sterile cells. When Fries ed the genus Tuburcinia, the first species which he placed under it was *T. Orohes,* the spore ball of which is composed of 1-3 larger central cells surrounded by npact layer of smaller, flatter cells. Contrary to the opinion of most previous ents of this genus, Liro considers the smaller outer cells as the sterile accessory and therefore, that this spore ball differs from that of ordinary species of Uros in no way. From examination of slides of Fries' original specimen kindly shed by Dr. Liro, the writers were able to confirm Liro's conclusions in regard e relative size of the cells; but it should be kept in mind that the separation of enera is not based on differences in size of central and peripheral cells but on ability to germinate. Microscopic examination of these slides did not disclose lifference in the outer cells which would prevent germination. Brefeld (Unter. A.D. Gesammtg. d. Myk. Heft. 12:180 and Pl. XI. 1895) has published excèligures of the germination of the spores of *Tuburcinia primulicola,* a species very ar to *T. Orobanches,* and he shows the peripheral cells germinating in large num- He was unable to find any sterile cells outside of those which germinated. does not mention any germination studies and there is no record in the literathat the germination of the spores of *T. Orobanches* has been observed. Until ermination of these spores has been studied, and until there is some concord of

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opinion among mycologists as to the constancy of the sterile layer of covering ce
we prefer to retain for the onion smut organism the name which has been in cont
uous use for the last fifty years.

The true onion smut fungus *U. cepulae* Frost, does occur, however, on otl
species of Allium. Clinton (8:451) reported it on specimens of *A. Nevadense* fr
Nevada. In England the disease is said to be more severe on leeks (*A. Porrum*) th
on onions (13:170) and was reported from France on this host as early as 18
(29:277). Quite recently (55:57) Zillig has reported that he was able to infect
fistulosum L., *A. globosum* Red., *A. odorum* L. and *A. Porrum* L.

One of the writers, before he was aware that Zillig was working on the sa
problem in Germany, began a series of inoculations by planting seed of all obta
able species in soil which was very heavily infested with *U. cepulae*. Records tal
every week after the plants came up gave the total percentage and severity of sm
infection for each species. A full description of these experiments and the resu
are published elsewhere (4). Briefly, it was found that out of 39 species which w
tested, 8 proved to be immune to smut, while 31 showed varying degrees of suscep
bility. Thirteen species were just as susceptible as the common onion in that
disease affected them in just the same way throughout the season. In five other
caused heavy mortality in the cotyledon stage but did not persist throughout
season. In 13 others the cotyledons were sometimes affected, but the plants rar
if ever died from the effects of smut. These results lead us to believe that if
numerous other species—there are some 250 species in the genus—were tested in
same way, a large proportion of those which reproduce by seeds would be found
be susceptible. (Many species escape the disease by reproducing only by bulble

Within the species *Allium Cepa*, the cultivated onion, there are numerous va
ties, but up to the present there are no data or observations to indicate that any
them show any degree of resistance to smut. It has been stated at various tim
however, that the white varieties are somewhat more susceptible than the red
yellow ones. Walker and Jones (50:236) tested several varieties, and Whiteh
(52:449) tested 21 varieties of onions and 11 varieties of leeks (*A. Porrum*) but n
was found which showed resistance. Anderson (4) tested 54 varieties of cultiva
onions but found no significant indication of resistance among them.

*Morphology and Life-History of the Smut Fungus**

If one examines microscopically the dusty black mass from the leaves or bu
mentioned above, he will find that each particle of dust is a spore (chlamydospo
of the fungus which causes smut. It is a compound spore composed of one la
central brown cell, to the surface of which are attached 15–40 smaller hemispher
cells (see Fig. 3A). The dark central cell is the fertile cell, while the numer
smaller surrounding cells, which are transparent, but with a brownish tint, are
sterile cells (pseudospores or accessory cells).

The spores get into the soil either by the rupturing of the sorus (pustule) or
decay of the infected part of the onion which has fallen to the ground. In the s
they may germinate at once or after a few weeks or months, or they may remain
years before germination occurs. In either case they grow into long slender bran
ing tubes (the mycelium) and in a favorable soil this growth may be sustained
many years even though onions are not planted again on the same field. T
mycelium does not produce other spores (*sporidia* or *conidia*) but it may break
into short pieces which are able to lie dormant for long periods and then germin
on the return of favorable conditions. The soil becomes so infested with spor
mycelium and these detached mycelial segments that without preventive measu
onions can no longer be raised on it.

Method of germination of the spores. In a previous publication Anderson (1:108)
described the process of germination as it occurs during the first few months after m
turity of the spores. Briefly it is this: A globose hyaline body, at first no larger than
of the sterile cells but later becoming as large as the fertile cell, develops on the surf
of the fertile cell (Fig. 3B). From this body one to eight germ tubes grow out (I

*In a previous publication from this station (1) the reader will find more detailed information on the
life history of *Urocystis cepulae*. In the present publication the seasonal life-cycle is outlined very bri

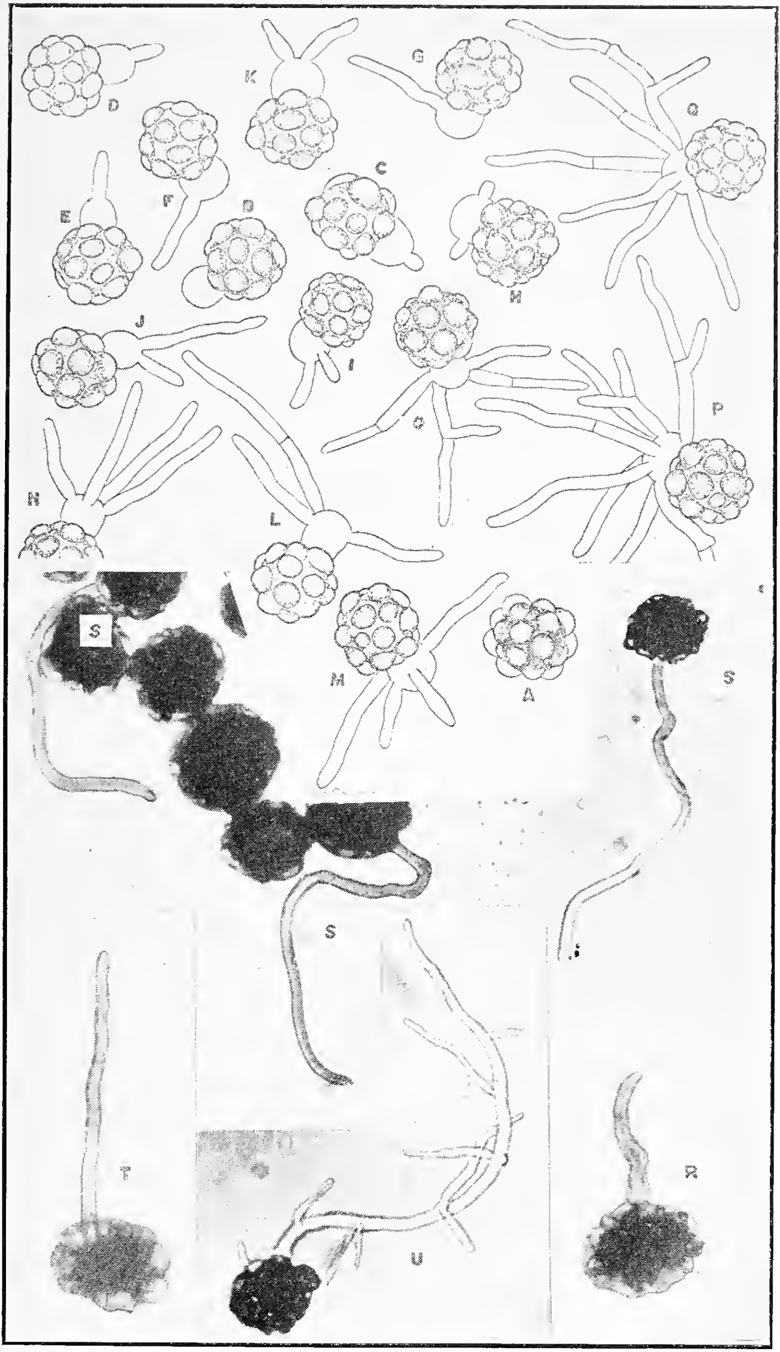

Fig. 3. Germination of onion smut spores. A. A fresh spore before germination. B-Q. Successively older stages of germination of spores three months after maturity. Camera lucida drawings. R-U. Successive stages in the germination of spores after ripened in soil for three years. Photomicrographs.

Q) and by elongation, branching and septation form a dense mycelium without any ication of sporidia. Subsequent to the publication of these results, smutted leaves e placed in damp soil in test tubes where they were kept for three years. At the ex-ation of that time the spores were again tested for germination by the same method vas used in the previously reported tests. The process of germination was now found e quite different from that which took place during the first three months after matur-

Most of the sterile cells had now collapsed and no longer presented the plump earance which they have on fresh spores. Germination began within 2-5 days after spores were sowed on the cold agar plates. The first striking difference was that e was no large globose body developed on the face of the fertile cell, but a single der tube grew out directly from the central cell (Fig. 3R-U). Occasionally two tubes ned to come from the same place, but the second one may have been merely a branch e first arising very close to the surface of the spore. Usually the germ tube remained le and unbranched until it had reached a length of 20–30 times the diameter of the e. Then it became septate and branched sparingly. The protoplasm disappeared the older cells but remained dense in the advancing tip cells. No sporidia were rved at any time even when the further development was examined daily until ses of mycelium a half-inch or more in diameter were formed. All the further devel-ent and behavior of the mycelium was the same as previously described after the nination of the spores according to the first process. The process of germination of e "after-ripened" spores is very similar to that described by Thaxter (44:142) and tehead (53) except that both of them found sporidia. The difference in germination ween fresh spores and after-ripened spores is susceptible of various interpretations, none will be attempted until after further investigations have been made.

t is commonly stated in the literature on onion smut that the chlamydospores for many years—any number up to 25 may be found—in the soil and then germ-e to infect the seedlings when onions are again planted. Such statements are neously based on the observation that smut recurs on a certain piece of land h has not been planted to onions for that particular number of years. It seems e probable that the smut is carried through those years in the form of mycelium g on the organic matter in the soil. Another possibility is that the spores or r organs of the fungus may have been washed or carried in some other way from s where onions had been grown in the interim. During the season of 1923 smut rred in destructive form on a plot of land on the experiment station farm which, e records showed, had not been planted to onions in at least 40 years, but this was adjacent to another field where onions had been grown during many years. nilar case is reported by Whitehead (52:444). There are numerous ways in h it could be spread from one field to another, *e.g.*, by surface washing, wind, , animals, direct spread of the mycelium, workmen, etc.

rom the soil the mycelium enters the very young seedlings by boring directly ugh the epidermis. Infection may occur only during a very limited period the epidermis is tender. The exact length of this period was determined by er and Jones (50:238) and by Anderson (1:120). Walker and Jones found "the plants became immune . . . between the nineteenth and twenty-fourth after sowing, when the cotyledon had about attained its full growth and as the leaf was emerging." Anderson found that they were no longer susceptible the 17th day under greenhouse conditions, but that "the period of suscepti- is not limited by the number of days during which the seeds have been in the but by the length of time required for the seedling to pass through certain s of development" and that "susceptibility begins to diminish from the time the knees emerge from the ground and little if any infection occurs after the eaf has emerged from the side of the cotyledon." Thus the conclusions from two investigations—carried out at the same time, but entirely independently, identical—that all infection occurs before the first leaf is developed—a period may be roughly stated as 3 weeks after planting. Walker and Jones very iously demonstrated that immunity after this period depends on the maturity tissues of the cotyledon or the successively developed leaves each of which in orms a protective sheath about the base of the next developing leaf.

s soon as the infecting mycelium has passed through the epidermis of the edon, it spreads rapidly in all directions, deriving its food from the cells of the g onion. After growing for a period of 5–10 days the mycelium forms dense s between the cells of the host plant and then the knarls are transformed into s of black spores which have been previously described. It must not be

understood, however, that the mycelium from a single point of infection gr
throughout the whole length of the cotyledon. On the contrary, a single mycel
probably never extends more than a quarter of an inch from the point of infec
and the ripe sorus is developed at that point. If there are a number of sori in
cotyledon—which is usually the case—they are the result of the same numbe
separate infections. Very long sori in the cotyledon are the result of anastomo
shorter sori.

Just at the junction of the young cotyledon and the first root there is a sl
swelling known as the root joint. Immediately above this is the growing point
region of less than a half inch,—from which place all new leaves start. This p
remains stationary throughout the further development of the onion bulb. I
infection occurs near the growing point the mycelium reaches this rapidly divi
tissue and as each leaf grows up it carries with it some of the infecting mycel
which spreads and sporulates in the leaves. When an onion once becomes infe
in the growing point, it never recovers. If, however, the cotyledon is infected
in the upper part the mycelium does not reach the growing tissues and the dis
is sloughed off with the cotyledon and the plant develops normally.

RELATION TO ENVIRONMENTAL FACTORS

Most plant diseases vary greatly in prevalence and severity according to
season. Certain kinds of weather favor them, others retard them. They ruin
crop one year and are entirely absent during other years. Onion smut, howe
differs from most common diseases in this respect: It is about the same every y
Some growers think they find it more severe during a dry year; just as many ot
think a wet year favors it. The writers have had occasion to watch the course o
disease for many years but have never noticed any marked difference in its sev
from year to year on the same field. Walker and Jones (50:240) conducted
trolled experiments in the greenhouse to determine the effect of variation in
moisture of the soil on the percentage of smut infection and concluded "that
moisture does not function as a factor limiting infection with onion smut within
limits at either extreme where good germination and growth of the host occur."

A similar experiment was conducted by the writers at the Massachusetts Ex
ment Station in which the seedlings were grown in pots of naturally infested
kept at moisture contents at intervals of 2 per cent. from 12 to 40 per cent. of
dry weight of the soil. Below 12 per cent. this soil was too dry for good germ
tion, while at the upper limit it began to decline rapidly from 34 per cent. Wi
this range the smut loss was almost total. Above 34 per cent. there was a dec
in the percentage of infection, but the soil was very muddy and it is not likely
any grower would plant onion seed in soil so wet as this. It is conceivable, howe
that rains immediately following the planting might keep the ground so wet
infection would be reduced, but probably the loss of germination on account of
soil would more than counterbalance the gain from decreased infection. The p
tically identical results of these two experiments conducted independently in
consin and Massachusetts indicate that the moisture condition of the soil in
spring is without influence on prevalence of the disease during that year.

Neither is there any indication that a warm spring in the Connecticut Vall
any more or less favorable than a cold one. All the onions here are planted in
early spring before the soil becomes very warm. Walker and Jones (50:247)
ducted experiments on the effect of soil temperature on infection and concl
"that a high percentage of infection may be expected up to 25° C. (=77° F.) a
which there is a rather abrupt reduction, leading to complete inhibition at 29
(=84° F.). There appears to be no lower limit of temperature for infection wi
the range where onion seeds will germinate and normal growth occur." They
plain the absence of smut from the southern onion regions, *e.g.*, Texas and Louisi
as due to the fact that in those regions the seed is planted in late summer when
soil temperature is too high for infection to occur.

The temperature experiments of Walker and Jones were also duplicated at
Massachusetts Experiment Station and the results were practically the sa
Onion seed germinated at all temperatures between 8° and 35°C., but the percen

ops off rapidly above 27° and is much retarded below 13°. It required 33 days for e plants at 8° to show above the surface of the soil. The optimum is between 15° d 27°. Smut was not entirely absent at any temperature tried, but the percent-e dropped off suddenly and rapidly above 27°. Below 27° there were no signifi-nt differences at any temperature. There seems to be no lower limit of infection thin the range of germination of the onion seeds. This suggests the possibility at smut might be avoided or diminished by delaying the planting here until the il became warm. Late planting, however, is not conducive to good crops in the nnecticut Valley and, in addition, this method has been tried (50:237) here with-t any beneficial effect.

It is apparent from the results of the experiments just mentioned that the only l temperatures which could influence prevalence of smut would be from 27°C. l°F.) upward. Does the soil of the Connecticut Valley onion region ever ap-oach such high temperatures during the infection period, *i.e.*, approximately dur-g April and May? We have no local continuous seasonal records for the soil, but ice all infection occurs within the upper inch of soil we may approximate it from e air temperature records during those months. The soil temperature during the at of the day, to be sure, may rise several degrees above that of the air, but we ly allow a latitude of ten degrees or more and still reach some conclusion. eather records at Amherst for the ten-year period 1915–24 show the mean hourly nperature for the month of April to be 45.8°F. and for May, 56.5°F. Even ough the soil temperature in parts of the field were 20° higher than that of the air which is beyond reasonable limits for any length of time—it would still not be h enough to limit infection. As far as Massachusetts is concerned then, soil nperature seems to be as unimportant as soil moisture.

We may conclude, therefore, that variations in weather conditions are without ect on the severity of smut infection. There is, on the contrary, very good evi-nce that certain soil factors may have a deciding influence. A survey of the nnecticut Valley region shows that fields are very unevenly infested. Onions vays suffer most in certain fields. In the same field, certain spots are very avily infested while other parts of the field suffer little. The location of these ots remains approximately the same year after year although the whole field is nted to onions each year and the treatment of all is the same. Such a condition nnot result from any lack of opportunity for the fungus to spread. It can appar-ly mean only that there is some soil factor which is right for the growth of or ection by the fungus in that part and not in the other parts of the field. Investi-ion with the object of determining this factor (or factors) is now in progress at s station, but it has not progressed to the point where any conclusions can be wn.

PREVENTION OF SMUT

When the ravages of smut first began to attract attention of New England onion wers (1850–75), it was thought to be connected in some way with the character manures applied to the soil, guano being held especially responsible. Remedies re therefore sought through change of fertilizers. Thus Horace Capron (7:224) gests: "A remedy for this disease must be sought by using less manure, or nures which are less stimulating and afford less nitrogen for the fungus to feed on. Alkaline manures are very destructive to the fungus. Wood ashes, lime, psum and seaweed are very efficacious."

Taylor (43:195), who first made a study of the spores and laid stress on their sence in the soil as a means of carrying the disease over winter and spreading it out, recommended that they be destroyed and the disease thus controlled, by ning heaps of dry weeds and rubbish on the infested fields. This recommenda-n was repeated by various writers during the next fifteen years, but it does not pear from the literature that anybody tried it. Walker (47:6) has recently ommended burning the onion tops after harvest and the avoidance of returning on refuse to the soil.

Farlow (14:174) was the first to suggest rotation of crops as a means of control. was led to believe from the statements of growers that the spores do not live in soil more than four years and thought that if a smut-infested field were planted to other crops for four years, it would then raise a smut-free crop of onions. He d not think that the spores were carried by wind and in order to prevent the carryi of spores to uninfested fields, he recommended thorough cleaning of all tools whi had been used on smut-infested land. Thaxter (44:138) on the other hand, fin that a badly infested crop of onions was grown on a field which had not been plant to onions for twelve years. Sirrine and Stewart (37:149) find in regard to the va of crop rotation: "it is the common experience of onion growers that even an oc sional change of the crops for one or two years gives appreciable relief; and it is o belief that a systematic rotation of crops would very considerably reduce the amou of loss from smut." Farlow was also the first to recommend that all smutted onio be pulled during the growing season while the crop is being weeded, and that th be removed from the field and burned. It is not recorded in literature that t method was tried by any grower.

The first accurate experiments of any value on control are those of Thax (44:146) who was at that time mycologist of the Connecticut Agricultural Expe ment Station. He applied various dry chemicals to the soil in the drills to s whether any of them would prevent infection of the seedlings by the fungus. T chemicals used were copper sulfate, iron sulfate, sodium sulfide, potassium sulfi potassium chloride, calcium chloride, sodium hyposulfite and flowers of sulfur. slaked lime was tried also in combination with some of them. The mixture of slaked lime and flowers of sulfur gave a fair percentage of control. The oth injured the germinating seeds, or were of little or no value in preventing smut, their use was impracticable. He repeated the experiments the following ye (45:103) and again was able to increase by a ratio of about 5:1 the number of onio which could be raised on badly infested land, by the use of flowers of sulfur. Th ter, himself, however, was not very enthusiastic in his recommendation of t method and two years later his successor, Sturgis (41:14) writes concerning it: " seems probable now that the measure of success attending this treatment w hardly warrant its extended adoption."

The sulfur-lime treatment was thoroughly tested by Sirrine and Stewart (37:15 their field experiments extending over a period of five years. As a result of all th experiments they conclude (37:145) "that the yield of onions on smutty land m be greatly increased by the application of 100 pounds of sulphur and 50 pounds air-slaked lime per acre in the drills at the time of sowing the seed. In seve instances the yield has been increased at the rate of more than 15,000 pounds p acre as compared with untreated plats. Sulphur alone has considerable value a preventive of smut, but seems more efficient when mixed with lime. The sulph and lime should not be applied broadcast as they appear to have no effect on t smut when applied in that way. The sulphur-lime treatment is recommend whenever the loss from smut is as much as one-third of the crop."

Thaxter (44:146) found that infection occurred only in the very young seedli stage. Thus, when the plants were started in sterile soil and then transplanted the field, they never suffered from smut. Sturgis (42:176) made extensive fie tests of this method and demonstrated that it was an absolute preventive of sm It was also recommended by Sirrine and Stewart (37:145). This most effective all methods of control has not been adopted by onion growers in general because t amount of labor and time required for transplanting is so great as to render it i practicable where onions are grown on a large scale.

Burying of the surface soil has been tried with some success, but the labor volved is excessive (37:149).

The use of larger quantities of seed on smut infested land has been tried (37:14 but as pointed out by Sirrine and Stewart "there comes a time when it is impossi to obtain a stand no matter how much seed is used." Such a method is also impra tical on a field which is unevenly infested, because the onions are too thick lightly infested parts of the field and laborious thinning is necessitated.

In 1900 Selby (35:76) began experiments in Ohio, using the lime and sul treatment as recommended by Thaxter, various other chemicals, quick lime and fo maldehyde. After the first year's experiments (1900) he abandoned all but t formaldehyde and the quick lime since they alone gave promising results. All t experiments were on seed sowed very thickly (about 40 pounds per acre) for t production of sets. During the second year he used only the quick lime and t rmaldehyde or a combination of the two and obtained a considerable degree of ntrol. In regard to his method of application we quote from his summary (36:51).

"To apply formalin, use at rate of one pound commercial formalin in 25–30 gallons water (1 oz. to 1½–2 gals.) and apply with drip attachment on seed drill at rate 500–700 gallons of solution per acre for onion set seeding (about ⅕-¼ as much r field onions) or apply with sprinkler upon the scattered seeds until well mois- ned, then cover with earth promptly.

"Apply ground quick lime or stone lime, better the former, at the rate of 75 to 125 ıshels per acre just before seeding, on the freshly prepared soil. If applied by ill, harrowing will not be required; if broadcast, harrowing should precede anting."

Stone (39) recommended formaldehyde at the rate of 1 lb. to 30 gals. (1–240) or oz. to a gal. of water (1–128). With the improved tank which he describes in tail he found that about 1200 ft. of drill could be treated with one gallon of the lution.

Within recent years all other methods except the application of formaldehyde ve been abandoned, since this has given good results and is the most convenient. rious concentrations of the solution and quantities per acre or given length of w have been recommended. The most recent and thorough investigations have en those in Wisconsin by Walker (47). After experiments of several years' dura- n he recommended the use of formaldehyde* at a dilution of 1–128 applied at the te of 200 gallons per acre, or one gallon to about 185 feet of drill (1–128–2960, or proximately equal to our 1–128–3000 formula).

In England, Whitehead (52:444) recently made control experiments in which he ated the seed with various percentages of sulfuric acid and with paraform, other periments in which the soil was treated with soot and salt, paraform, bleaching wder, lime, nitrate of soda, sulfur and lime, calcium cyanamide, carbon bisulfide d formaldehyde. In the summary of the work he recommends only formaldehyde.

We may briefly summarize the methods of control which have been recommended the past and their present status:

1. Modification of the fertilization of the land has been of no avail. We do not lieve, however, that the possibilities of this field of investigation have been ex- usted.

2. Removal or destruction of diseased onions or refuse is wasted time.

3. Rotation of crops is of little, if any, value because of the length of time during ich the fungus lives in the soil and because of the facility with which it may be roduced from neighboring fields. It is also not economically practicable on high- ced onion land.

4. Search for resistant varieties has yielded nothing up to the present, but uld be continued.

5. Burying the surface soil is too expensive to merit consideration.

6. Sterilization of the entire field by heat or chemicals is also too expensive.

7. The use of larger quantities of seed is ineffective.

8. The use of transplanted seedlings is an absolute preventive, but such a thod of culture is considered too laborious by growers of the Connecticut Valley ion.

9. The use of sets is just as sure a preventive. This is being practiced more ex- sively every year, not only because of the smut situation but also because of less nage from thrips and of larger yields. The early harvesting of the crop, however, distinct disadvantages from the storing and marketing standpoint.

0. Chemicals other than formaldehyde have proved worthless, injurious, or at t, very much inferior to that chemical. Sulfur and lime have given the most mise, but are no longer used.

1. The use of formaldehyde is the only treatment which is now recommended extensively used. The principal objections to the formaldehyde method are—

(1) the use of large quantities of water which greatly increases the labor at planting time, and

(2) danger of injury to the seed.

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*Walker also tried (48:323) the sulphur and lime method described by Sirrine and Stewart but found it ior to the formaldehyde method "both as to efficiency in controlling the disease and ease of proper ication."

It was with the object of reducing these difficulties to the practical minimum t field experiments were undertaken by this station. The problem was to fin formula of application* in which the water should be reduced to the lowest possi amount, but without serious damage to the germinating seeds.

The Cowls Farm Experiment, 1919

This experiment was located on a field so heavily infested with smut that loss was almost complete during the preceding year. Three formulas were us 1–64–3200, 1–96–3200 and 1–128–3200. The rows were 150 feet long, two untrea rows alternating with each plot of four treated rows and the whole series in triplica thus giving a total of 1800 feet of row treated according to each formula. Pl were planted on April 22. The soil was fairly moist when planted; there was o a slight precipitation during the next week, but the month of May was very rai No difference between the rows was apparent when they first came up but withi short time the treated rows looked greener and were thicker because of the dyin the smutted plants in the untreated rows. This dwindling continued through the summer as more of the smutted onions died and disappeared. On June 2, number of onions in measured lengths of the rows was counted. Also the percent of smut among those standing was determined. From an inspection of these d (Table I) it is apparent that there had been a large shrinkage from smut before t date and that half, at least, of those still standing in the untreated rows w smutted. Smut was not eliminated from the treated rows but it was so reduce amount that the rows were too thick for the growing of bulbs of good size. Dur August thrips did serious injury, causing the tops to die prematurely. The bu on the check rows were much larger than on the treated rows because, after mos the seedlings died, they were far apart and had thus opportunity to grow lar Very few of the diseased onions were still standing at harvest time and most of th were rotted at the base. Only rarely did one attain a diameter of one inch. number of sound bulbs in each row was counted as they were pulled. After t had dried for a few days, each plot was also weighed separately. The data is su marized in Table I (p. 27). The comparative yields of treated and untreated r are also shown in Fig. 4. The difference between the results secured by any of three formulas is not large. Any of the three shows a gain of over 250 bags (lbs. in a bag) per acre. The control secured by the use of any one of the formu was satisfactory.

If one prefers to measure the efficiency of the treatment by the gain in pour the 1–96 formula was somewhat the best. If, however, he wishes to consider *number* of healthy onions at harvest time as the basis of comparison, the 1– formula is somewhat better.†

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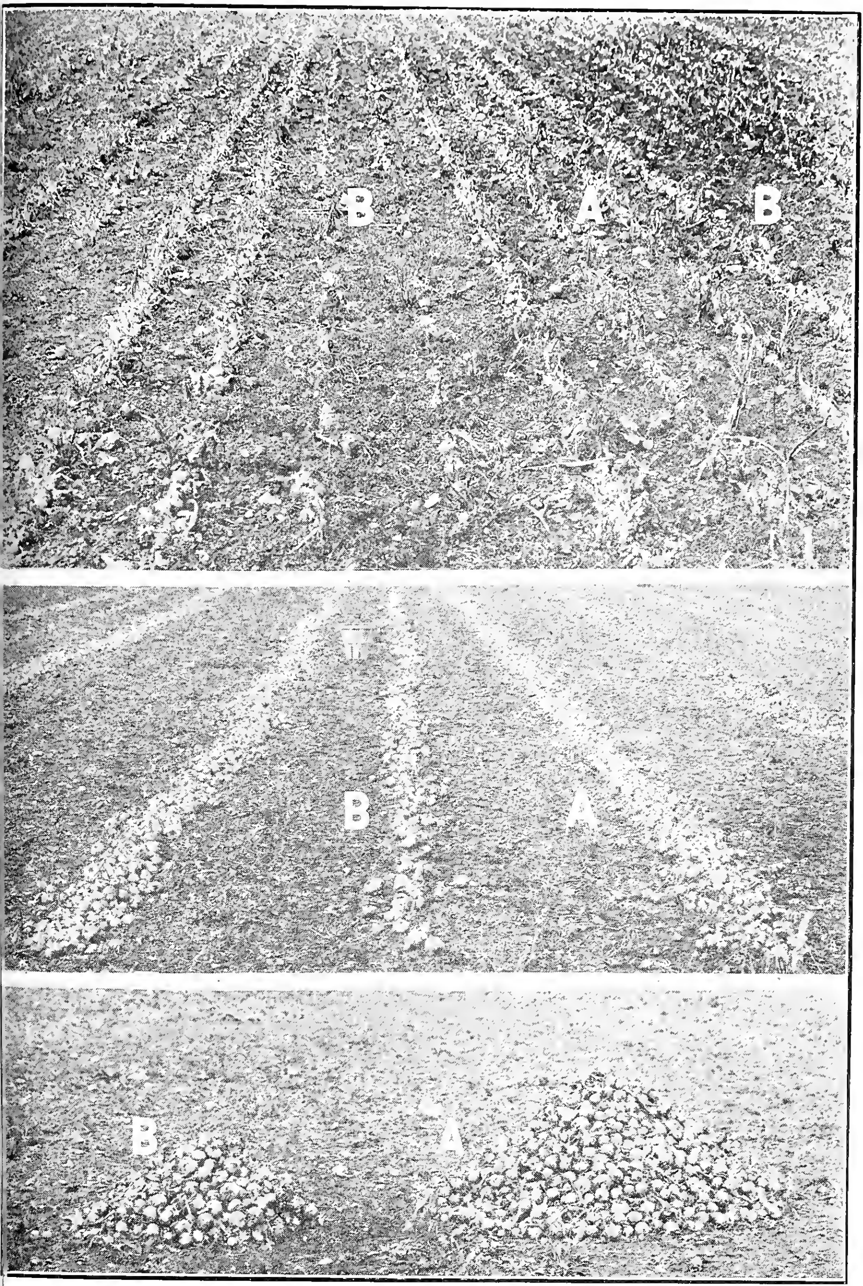
*Formaldehyde (*i.e.* the 32–40 per cent. solution of the gas in water) cannot be applied in the con trated form to the seeds in the row because even a very small quantity prevents the seeds from germina It is therefore necessary to dilute it with water. The first question to be answered then is: how m should it be diluted? This is the first variable in the experiments but this variable depends in turn second variable viz. the rate at which the diluted solution is to be applied to the row. For example, a dilution is excellent if a gallon of it is applied to 700 feet of row but disastrous when applied to 200 feet worthless when applied to 1400 feet. The numerical expression of these two variables is called the "f ula of application." For all of our experiments it is written in terms of pints of formaldehyde—pin water—feet of onion row. To illustrate: the formula 1–50–3000 means one pint of formaldehyde is dil to 50 pints with water and the 50 pints of diluted solution applied to 3000 feet of onion row. Thus first and second figures express the rate of dilution while the second and third figures express the ra application of the diluted solution to the row in terms of pints of solution and feet of row. In the litera on onion smut control the rate of application is commonly expressed as so many gallons per acre of on This is undesirable because we do not treat acres but rows, *i.e.*, the amount of solution should be pro tionate to the number of feet of row and not to the area of the field. The number of feet of row in an varies according to the distance between the rows. Different growers plant the rows at different inter Even in the restricted area of the Connecticut Valley one may find fields of onions planted at 12, 13, 15 inches and none of them is uncommon. In other sections of the country under different methods of ture other intervals are used. In order that results obtained at one place may be compared with those another, it is desirable that formulas be expressed according to length of row treated and not acres. should also be kept in mind that a direct comparison cannot be made between the results of the use of formulas in which both variables are fluctuating at the same time: One must remain constant whil other is being changed.

†*Methods of calculating the results*: The writers have given considerable thought and attention to question of the most accurate method of calculating and comparing the results obtained by the use o different formulas of application. The methods which we have tried—most of which are in use by o investigators—are:

1. By counting the number of smutted seedlings when they are *in the cotyledon stage*. This meth



:. 4.—Formaldehyde treatment for smut. Yield from 4 treated rows (A), compared with 4 un-
treated rows (B).

Station Farm Experiment, 1919

The experiment on the Cowls farm was duplicated as regards treatments, but on a smaller scale, on a badly infested plot on the Station farm.

The check rows gradually dwindled throughout the summer while the stand on the treated rows remained excellent. No differences between the results obtained by the use of any of the three formulas could be observed. Through a mistake, the onions of this plot were harvested in the absence of the writers and final data on yield were not obtained. Unquestionably, however, they would have paralleled the yield data for the Cowls farm.

Greenhouse Experiments, 1919–20

During the winter a greenhouse bench 4 x 16 feet was filled with soil from a badly infested field. Three crops of onions, raised in succession, were treated with formaldehyde of different formulas. Commercial formaldehyde was applied at the rate of one pint to 2400, 2800, 3000 and 3200 feet of row. Dilutions from 1–8 up to 1–128 were used. Without presenting all the data, we may state the tentative conclusions at which we arrived as a basis for the field experiments of the following year:

1. The percentage of control was not appreciably greater when one pint of commercial formaldehyde was applied to 2400 or 2800 feet of row than when applied to 3000 or 3200 feet.
2. Concentrated formulas such as 1–48–2400, 1–32–2800 and stronger cause serious injury and cannot be used.
3. The most important indication of the series was that within wide limits, the amount of dilution is not a factor of any great importance *as far as control of smut is concerned.*

C. A. Clark Farm Experiment, 1920

This experiment was on land in Sunderland where onions had been grown for 40 or 50 years. The soil, however, was not as thoroughly infested as that on the Cowls farm used during the previous season. The part selected for experiment included 10 rows, 267 feet long, 12 inches apart, seeded at the rate of 7 pounds per acre. The plots were seeded May 3, the soil at that time being wet and heavy after a backward

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inaccurate because it makes no distinction between those which are badly affected and will die and those which are slightly affected and may produce good onions. Also we have found that it is impossible to distinguish all the diseased plants because many of the lesions are below the surface of the soil.

2. By counting the percentage of smutted plants among those which are standing at some definite period *in the early summer, but after the cotyledon stage.* This was done in the Cowls farm experiment just described and is commonly used by other workers on onion smut. This method is worthless because it does not count those which have already died from the disease and disappeared. We have repeatedly noted that seedlings begin to die within three weeks after planting and the mortality is then heavy for a few weeks. When a young plant dies it shrivels and decomposes so quickly that no trace of it can be found after a very few days. Obviously such plants cannot be taken into consideration in calculating by this method

3. By removing and counting the plants *as fast as they succumb to smut.* This requires a thorough inspection about twice a week for a period of some four weeks, after which all diseased plants may be pulled once it is certain that they will not recover. This is certainly the most accurate method, but under field conditions involves so much labor that it is precluded. We have, however, used it in greenhouse experiments with satisfaction.

4. By counting and comparing the number of *healthy* bulbs in the row at harvest time or shortly before. This does not assume that all onions which have disappeared from the rows during the summer have succumbed to smut, but that all other agencies which would destroy the plants previous to this time would operate equally on all the rows. Therefore, the benefit derived by the grower can be determined by direct comparison of the figures thus obtained. From the experimenter's standpoint it is not quite satisfactory because it does not take into consideration the number of plants which were prevented from germinating on account of the use of formaldehyde of a certain formula. In the experiments of the last season we have determined the amount of such injury by comparing the number of plants which came up and then computing the control on the basis of those which remain. This fourth method has been used throughout the experiments here as being the most nearly accurate practical method of comparing the results obtained by a given treatment.

5 By comparing the *yield of onions in pounds or bushels.* This method is inaccurate because, as every onion grower has observed, the onions in a thin row (such as they are when thinned by smut) being further apart, are larger than in a thick row; therefore, bulb for bulb, are heavier. This difference, however, represents the gain in weight secured by growing bulbs further apart, and in no case could be interpreted as having any relation to the application of formaldehyde. If larger bulbs are desired, the result could be much more economically obtained by planting a smaller quantity of seed per acre while using the formaldehyde. This fifth method was used by the writers during the field experiments of 1919 and 1920 and the final weights are included in the tables, but they should not be considered as accurately gauging the results of the experiments.

spring. Also it rained within 24 hours after the seed was planted and the entir season was rainy.

The formulas used in this experiment require a few words of explanation. Sinc there was considerable smut in the treated rows during 1919 it was thought best t cut down the distance treated with one pint of the commercial formaldehyde fror 3200 to 3000 feet. This also had the advantage of being approximately the sam rate of application as was being used in the other states; therefore, our results coul be more readily compared. The formulas 1–48–3000 and 1–32–3000 were added t see whether a more concentrated solution would give better control without injur under field conditions. In order to test the effect of increasing the length of rov treated with one pint of commercial formaldehyde, the formulas 1–50–4000 an 1–50–5000 were added. From the standpoint of the growers, the 1–50 dilution i the most convenient because most of them use 50 gallon barrels for drawing th water and they all have gallon jugs or cans. It is, therefore, a simple matter to ad a gallon of the commercial solution to each barrel of water.

Observations on the course of the disease throughout the summer coincided wit those of the previous season. The percentage of smutted plants was not counte during the growing season for reasons previously stated. All the onions were pulle and counted on September 4. A week later they were topped and weighed. Th data taken are recorded in Table II (p. 27).

In interpreting the results of this experiment the fact that the soil was very we at the time of planting must be taken into consideration. The important influenc which this factor exerted was understood only after the experiments of later year We may draw the following conclusions from the data presented in Table II:

1. The highest percentage of control was secured by the use of the concentrate solutions: thus, the 1–64–3000 was the best*, but not much better than 1–32–300 and 1–96–3000.

2. No advantage was gained by the extreme dilution and use of the large amoun of water required for the 1–128–3000 formula. Three of the other formulas gav better control and others were not much inferior.

3. The decided drop in the percentage of control secured by the 1–50–500 formula indicates that (during a wet spring) the amount of formaldehyde was in sufficient. It resulted in a fair amount of control—40 per cent. increase over th untreated plots—but much below the benefit secured by the use of more formalde hyde per acre. The 1–50–4000 formula gave good control, but the yield was no quite so high as for some of the others.

The poor showing made by the 1–48–3000 formula is unexplainable in view o the good showing of the formulas just above and just below it.

The Kuzmeski Farm Experiment, 1920

The field on which this experiment was located is in Leverett and was seriousl infested only in spots. The seed was planted May 3, the soil moisture condition being about the same as previously noted for the Clark farm. Only two formula were used, viz., the 1–96–3000 formula which approximated the formula which gav the best control during the preceding season, and the 1–50–5000 formula previousl mentioned in the account of the C. A. Clark farm experiment. Eight rows, eac 436 feet long, 13 inches apart, were treated with each formula, and four rows wer left untreated as a check. Data for this experiment are recorded in Table III (p.27)

The results shown in the table confirm the conclusion from the Clark farm ex periment that the use of one pint of formaldehyde to 5000 feet of drill is insufficien for the control of smut during a wet spring. Entirely satisfactory control was ob tained by the use of the 1–96–3000 formula.

C. A. Clark Farm Experiment, 1921

The experiment of 1920 on this field was practically duplicated during the seaso of 1921 but with the addition of some more concentrated formulas. The soil, how

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*In this connection, it may be noted that Walker (48:324) during two years out of his four years' ex periments secured his highest yields by the use of the 1–64 dilution, while during the third year, it wa such a close second to the 1–128 dilution that the difference was almost negligible. Despite these results he recommended the 1–128 dilution.

ʼer, was dry and there was no rain for at least two days after the seed was sowed on pril 13. The weather continued cold and the seed came up very poorly. When it d come up there was a striking difference between the treated and untreated rows. he checks were much thicker and appeared so throughout the season. There was very obvious injury from the formaldehyde, irrespective of the formula used. The :iters were informed by onion growers who were in a position to know the facts of e case, that growers all through the section had the same trouble with formalde-ʼde during 1921 and that many fields of onions were plowed under because of the duced stand.

No yield data were taken in 1921 because the onions were harvested by mistake the absence of the writers and no records were kept.

After the experience of 1921 it was decided that further progress in the search r the best formula could not be made until the factors which cause formaldehyde injure were determined. The investigation of this problem was not finished ıtil 1922, but since it has an improtant bearing on the subsequent experiments, shall consider the findings at this time.

Formaldehyde Injury

At first it was thought that the injury of 1921 was due to some difference in the mposition of the chemical. Samples from all available sources were therefore llected, including among them samples of the same material which we had used ıring the previous years and which had not caused injury. Chemical analyses of e samples by Dr. Holland of the Chemistry department, revealed no differences in mposition which were of sufficient size or character to warrant a suspicion of their xic effect. The manufacturers assured us that there had been no change in the ethod of manufacture of formaldehyde. The most apparent difference was in the rcentage of methyl alcohol contained in the various samples. The sixteen sam-es were next tested simultaneously on onion seed sowed in greenhouse benches, ing for each the formulas 1–50–5000, 1–50–3000, 1–100–3000 and leaving un-ated rows between the plots. In order to see what effect variation in the per-ntage of methyl alcohol would have, samples containing known percentages from 4 per cent. to 16 per cent. alcohol were included in the tests. Without discussing e results in detail, they may be briefly stated as follows:—

1. The source of the formaldehyde was without influence on the percentage of ants which came up.
2. Variation in the percentage of methyl alcohol made no difference.
3. With all samples and every formula used, formaldehyde *retarded* germina-on for a day or two and
4. With all samples and formulas, formaldehyde *prevented* the germination of a rtain percentage of the seed, this loss being more apparent when a more concen-ated solution was used or where the quantity of the solution was increased.

The results of these experiments eliminated the possibility that the losses of 21 were referable to difference in the character of the formaldehyde.

Since there had been no differences in the formulas or method of application of rmaldehyde nor in the treatment of the soil in 1921, there appeared to remain only e character of the season itself as a possible explanation of the trouble. The aracter of the spring weather could obviously affect the soil—where the injury curs—in two ways: (1) in the percentage of moisture and (2) in the temperature. periments were undertaken with the object of determining to what extent the rcentage of injury is influenced by variation in the percentage of moisture in the il. The effect of the soil temperature on injury has not been determined as yet.

These experiments have been described in detail in a previous publication (2). r our present purpose it will be sufficient to quote from the summary of that per:

"When a concentrated formula like 1–50–3000 is used, the amount of injury pends on the moisture condition of the soil. Injury varies inversely as the per-ntage of moisture.

The amount of injury may be reduced by diminishing the amount of the solution plied per unit of row, but the percentage of smut control is probably also reduced.

The amount of injury in a dry soil may be reduced by increasing the dilution of the formaldehyde without at the same time reducing the actual amount of form dehyde per unit of row.

The amount of injury can be predicted from the moisture condition of the s on the day of planting. It is not affected by weather conditions during the subs quent days.

The grower could save time and labor by changing his formula according to t soil condition at the time of planting.

More seed should be applied when formaldehyde is used."

The final results of the formaldehyde injury investigation were not availab before the experiments of 1922 were started. Hence the soil moisture and the pe centage of loss from formaldehyde injury were not determined.

C. A. Clark Farm Experiment, 1922

The experiment was repeated on the same field during 1922. Twenty-six ro 500 feet long, 12 inches apart were sowed at the rate of six pounds of seed per ac on April 26. The soil was dry and no rain fell during the next week which w windy, cool and dry. Different samples of formaldehyde were tried in which t percentage of methyl alcohol was extremely small (4 per cent.) or very high (16 p cent.). Also comparative tests were repeated with the 1–128–3000, 1–64–300 1–50–5000, and 1–50–4000. Formaldehyde injury was evident when the seed can up but unfortunately no records of its comparative extent or of the soil moistu conditions were made. The onions were harvested on August 25. The yield da are recorded in Table IV (p. 28). It will be noted from this table that the resul are quite different from those obtained in 1920 on the same field (cf. Table II). T highest yields were secured with the dilute formula, 1–128–3000, while in 1920 it w the concentrated formulas, 1–32–3000 and 1–64–3000, which gave the highe yields. In 1920, the 1–50–5000 gave the lowest yield while in 1922 it was next the best. This difference can be easily explained, however, in view of the differen in the moisture conditions of the soil at seeding time. The low yields obtained b the concentrated formulas like 1–50–3000 in 1922 were due to reduction of the star through formaldehyde injury when the soil was very dry. They do not indicate lack of control because, when less formaldehyde was used (1–50–5000) the yield w increased.

As to the effect of the methyl alcohol, the data show a much larger yield throug the use of formaldehyde with a low percentage of methyl alcohol. Up to the pre ent, however, the writers have not had opportunity to repeat this test and woul hesitate to draw any conclusions from the results obtained on these two rows durin one season.

Kuzmeski Farm Experiment, 1922

This was on the same field as was used in 1920. On April 25 when the seed wa sowed the soil was very dry and continued so for the next week or more. The expe iment included 16 rows, 220 feet long, 13 inches apart, seeded at rate of four pounc per acre. The observations throughout the summer coincided with those made o the C. A. Clark farm the same season. Smut was serious only in spots; therefor the harvest data do not really show how complete was the control (since all th onions in the entire row were counted and therefore considerable stretches of ro where there was little smut to control were included). In the worst places hardl any onions remained standing in the check row while there was a normal number i the treated rows. Only one dilution was used on this field but it was applied to th row at three different rates. The final results (presented in Table V (p. 28) con firm the conclusions drawn from the C. A. Clark farm experiment of the same year viz., that the largest yield is obtained by using the 1–50–5000 formula, during a sea son when the seed must be sowed in a dry soil. The difference is due to formalde hyde injury and not to lack of control of smut.

The Objects of the Field Tests of 1923

Differences in yields secured by the various formulas in 1922 were the results o variation in (1) the control of smut and (2) the number of seeds prevented fron rminating by the formaldehyde. The presence of these two variables made the :erpretation of the yields very uncertain. An effort was made in the experiments 1923 to determine to what extent each of these factors was responsible for the riation in yield. This was accomplished by first determining the extent of the emical injury. During the third or fourth week after planting, when it was ought that practically all the plants which would come up were visible and before y of them had disappeared from smut or damping off, the number of plants in each w was determined irrespective of whether they were diseased or not. Compari-n of these with the untreated rows determined the extent of the chemical loss. ie relative amount of loss from smut was determined at harvesting by subtracting e number of sound bulbs from the number of seedlings which escaped chemical ury. It is not thereby assumed that all the plants which died in the interim were led by smut but that other agencies acted equally on all the rows. Also in order check up under field conditions the influence of soil moisture at planting time, the rcentage of moisture in the soil one inch below the surface was calculated for each perimental field on the day of planting.

Allen Clark Farm Experiment, 1923

This experiment was located in North Amherst on land heavily infested with iut at one end but very lightly at the other. It included 28 rows, 283 feet long, inches apart, seeded at the rate of six pounds per acre. The ground was fairly oist, containing 17 per cent. water with a retentive capacity of 65 per cent. of the y weight. It was planted on April 27 and there were heavy rains on the 28th and th. The rain probably came soon enough to affect the results of the treatment. spections while the onions were coming up and comparison by counting the seed-gs at the end of a month showed the chemical injury to be negligible in this field. i September 4, when the onions were ready to harvest, the sound bulbs in 100 feet each row on the more heavily infested end of the field were counted. The results, esented in Table VI (p. 28) are about what might be expected when the soil was ither extremely dry nor extremely wet. The highest yields were secured with the rmulas of medium dilution (1–64–3000, 1–75–3000) or where the rate of distribu-n was medium (1–50–4000). None of the formulas failed to control, but the 50–5000 was least satisfactory. The appearance of the field four weeks before rvesting is shown in Fig. 2.

Kuzmeski Farm Experiment, 1923

This experiment was on the same field as the experiments of 1920 and 1922. It nsisted of 24 rows, 436 feet long and 13 inches apart, seeded at the rate of six unds per acre on April 21. The soil was extremely dry and dusty. A high wind ring the day and the succeeding days kept the upper layer in the same condition a week. The moisture was 6 per cent. and the retentive capacity 45 per cent. of e dry weight of the soil. All conditions were ideal for a high percentage of formal-hyde injury.

Examination when the onions were coming up and counting the number of seed-gs when it was judged that all had come up, showed that the injury was certainly that was predicted. On September 3 the number of sound bulbs remaining were unted. The data on this experiment are summarized in Table VII (p. 29). iese data show that there was severe injury with all formulas used. The 1–50-00 formula caused the least loss but that was 20 per cent. Even when the solu-n was diluted 1–100 there was a loss of 36 per cent. It is doubtful whether any actical formula can be used under these very dry conditions which will eliminate is loss. Under these conditions it is probably best to use the 1–50–5000 formula d increase the amount of seed enough to offset the formaldehyde injury.

Station Farm Experiment, 1923

This was the same field on which the experiment of 1919 was located. It con-ted of 40 rows, 12 inches apart and 75 feet long, seeded on April 26 at rate of six unds per acre. The soil was very dry and remained so for 48 hours after planting.

The moisture was 12 per cent. and the retentive capacity 64 per cent. of the d weight. Such a condition was favorable for a high percentage of formaldehy injury and when the onions came up the injury was apparent. The percentage chemical loss was determined on June 1 and the yield data were taken on August 3 The data, presented in Table VIII (p. 29) show that the highest gain was obtain by the use of the 1–50–5000 formula and the next by the 1–64–3000 formula. T injury caused by the 1–50–3000 formula was so severe that there was an ultima loss even though smut was controlled very effectively. On such a soil the 1–50–50 formula is undoubtedly the best.

Conclusions from all of the Formaldehyde Experiments

After five years of experimentation, the writers came to some fairly definite co clusions in regard to the control of onion smut with formaldehyde. These concl sions, which will now be briefly stated, are supported by the data which have ju been presented.

1. Smut can be controlled in any field in the Connecticut Valley and during a season by the use of a formaldehyde solution.
2. Extreme dilutions such as one part of formaldehyde in 128 parts of wat involving the use of a large amount of water, extra labor and inconvenience, are n necessary under the conditions which prevail here.
3. Within fairly wide limits, the control of smut is not dependent on the dilutic but on the actual amount of formaldehyde applied per unit distance of row. Th the concentration is not limited by lack of control, but by danger of injury to t seeds.
4. Any formula for the application of formaldehyde which is strong enough control smut, also causes a certain percentage of the seeds to fail to germinate. T injury is especially noticed when the soil is very dry at planting time.
5. Formaldehyde injury varies inversely with the moisture content of the so and directly as the concentration of the solution and the amount of such soluti applied per unit length of row.
6. The grower may reduce the loss from formaldehyde to a very small percenta and at the same time get better control of smut by changing his formula of applic tion according to the moisture conditions of the soil on the day when the seed planted.
7. From the standpoints of (a) profitable (but not necessarily maximum) pr vention of smut, (b) minimizing the labor of drawing water, (c) ease of mixing t solution, (d) maximum reduction of the weight of water which must be carried the drill, and (e) avoidance of severe chemical injury, we recommend the followi as the most practical method of application:

If the soil is very dry, use the 1–50–5000 formula; if fairly moist, the 1–50–400 and if wet, the 1–50–3000 formula.

Or this might be expressed to the grower thus:

Put one gallon of formaldehyde into a 50-gallon barrel and fill to the top with wat If soil is very dry, apply at rate of one barrel to one acre of onions (13 inches apart). the soil is medium moist, apply 1¼ barrels, and if wet and heavy, 1⅔ barrels per acr

8. On a dry soil the amount of seed per acre should be increased.

The Formaldehyde Tank for the Onion Drill

The formaldehyde solution is applied to the row from a tank attached to t seeder. Various kinds of tanks and methods of regulating the flow of the solutio from them have been used and described by previous investigators (5:161).

In order that the control of smut be effective and injury reduced to the minimu it is important (1) that the rate of flow be uniform and (2) that the operator ha some means of knowing just how much solution he is applying. These two requir ments were doubly important for our experimental work.

In order that the data obtained might be reliable, a machine was needed whic would distribute evenly and with a fairly high degree of accuracy any desired qua tity of solution on a stated length of row. For this purpose the regulating appar tus on all of the machines which have been described before was found to be wort

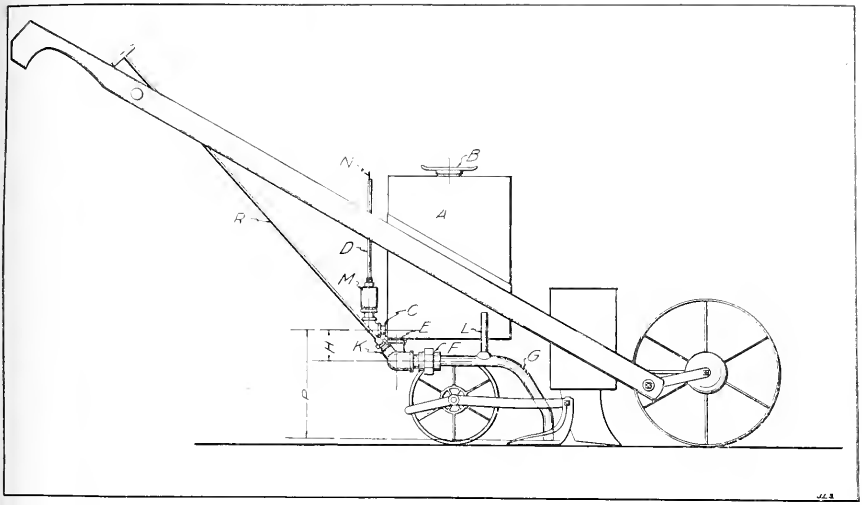

Fig. 5.—Mechanical drawing showing details of formaldehyde tank construction.

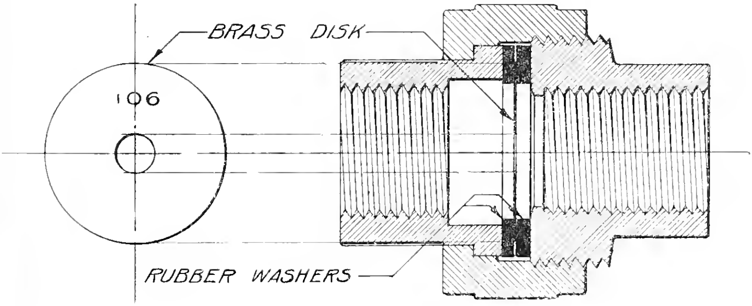

Fig. 6.—Sectional view of union in outlet pipe, with disk and washers in place.

s. None had a valve which could be set so that the operator would know when started across the field how much solution would be applied per hundred feet. tual tests of the different types of tanks showed considerable variation in the flow pending on how full the tank was. A 14-quart tank described below required re than twice as long to deliver the last quart as it did the first. The one-gallon per tank first constructed by Stone (Mass. Agr. Expt. Sta. Circ. 21) — which till in the possession of the Station—was tested and showed a difference in time 15 per cent. between the first and last point. None of the tanks previously cribed has any method of correcting this error. None of them has any provision eliminating the error due to variation in the speed of the operator. In short, re were so many sources of error and variation in all of the machines described to the present that they were found to be utterly unsuitable for accurate research dies and a new tank and method of regulation had to be devised. The one which finally evolved after experimenting with many different modifications is illus-ted in Fig. 5 and described below.*

The tank itself (Fig. 5A) is a 14-quart cubical galvanized iron box attached be-en the handles of the drill just back of the seed box. The bottom of the tank is flat but has a slight slope to a lowest point at the rear from which the solution onducted through a ½-inch pipe (E) to the stopcock (K) and to the union (F). m there it is led through a ⅜-inch flexible block tin tube (G) and distributed on seed and soil just back of the seed spout and in front of the coverers. The valve is operated by a ¼-inch iron rod (R) from the rear end of the handles. It has hing to do with the regulation of the flow but merely starts or stops the stream he ends of the row or wherever desired.

The rate of flow from the tank is regulated by a series of brass disks with central rtures of graded sizes. A disk is held in place between rubber washers in the on of the outlet pipe (Fig. 6). Any number of these simple brass disks may quickly cut out with tin shears from a sheet of brass. A hole is drilled through center of each disk and this is enlarged with a rat-tail file to the proper size for delivery of a gallon of solution in the previously calculated number of seconds ch the operator wishes to use. The number of seconds required to deliver a on of solution is then stamped on the disk (Fig. 6). The size of the aperture ded depends on the formula of application which the operator wishes to use and rate at which he walks. The number of disks which the experimenter or grower ds depends on the number of formulas he wishes to use, and the number of men, lifferent speeds of walking, who expect to push his drill. In our own experi-ntal work seven different formulas of application were being tested and the drill pushed at different times by three operators, the first one walking 4 feet per ond, the second one 4½ feet per second and the third one 5 feet per second. Thus ore the experiments were completed there were 21 disks. The operator could ckly find the proper disk by reference to a table attached to the side of the tank ble 1).

TABLE 1.

licating the Disks of the Onion Drill to be Used According to the Speed of Workman and Formula Desired

Formula	4 Ft. per Sec.	4½ Ft. per Sec.	5 Ft. per Sec.
1- 50-3000	120	106	96
1- 50-4000	160	142	128
1- 50-5000	200	178	160
1- 32-3000	188	167	150
1- 32-4000	250	222	200
1- 64-3000	94	83	75
1-128-3000	47	42	37.5

*The authors are glad to acknowledge the very helpful cooperation of Professor C. I. Gunness and ressor J. L. Strahan of the Department of Rural Engineering, whose aid in the solving of some of the anical difficulties and the preparation of mechanical drawings, has been invaluable.

To illustrate: If the operator found that he walked at the rate of 4½ feet p second and he wished to use the 1–64–3000 formula, a glance at the table would t him to insert in the union the disk stamped with the figure 83. Such a large nu ber of disks will be needed only by the experimenter. The practical grower wou not have occasion to use more than two or three and could make them as desire This method of regulation was found to be very satisfactory and has the advantag of (1) permanent accuracy; no variation with wear or play; (2) cheapness and ea of construction within the reach of any grower; (3) simplicity; no complicat mechanism to be frequently out of repair; and (4) great elasticity, since a disk m be quickly made to suit any desired rate of flow.

The next modification was made for the purpose of correcting the variation flow due to difference in head of the liquid as the quantity in the tank diminish All of the tanks which the writers have seen described have loose-fitting lids in t top through which the solution is poured to fill the tank. As the solution flows o through the outlet pipe the space which it leaves in the tank is immediately fill with air which comes in around the lid. Such an arrangement makes the rate flow entirely dependent on the height of the water in the tank and as a result, t flow is much more rapid when the tank is full than when it is nearly empty. order to determine the extent of such variation, the 14-quart tank just describ was filled and the water permitted to run out with the lid loose or removed entirel The time required for delivering each of the successive quarts was determined wi a stop watch and the average of three tests is indicated in Table 2:

TABLE 2.

Rate of Flow of Each Successive Quart of Liquid from 14-Quart Tank (Ope

Quart	Seconds	Quart	Seconds
1	17.7	8	24.3
2	18.8	9	25.2
3	19.2	10	26.9
4	20.0	11	29.3
5	20.5	12	32.3
6	21.6	13	34.6
7	22.8	14	39.4

Thus, the operator who started with a full tank would be putting on the fir part of the treated row double the amount which he put on the last part. The r sulting control or injury would naturally show a similar variation. Data deriv from the use of such a tank cannot be accurate. The variation in even the sm tank described by Stone has been noted above. In order to make our control da reliable it was absolutely essential that this variation be eliminated. After consi erable experimentation this was finally very successfully accomplished by modifyi the tank thus: Instead of a loose-fitting lid, a screw cap (B), of 2-inch diamet (such as is commonly used on an automobile radiator) is used for closing the openi in the top. When screwed down with the shoulder against a rubber washer, th makes the top air-tight. A stand-pipe (D) parallel with and as high as the side the tank is connected with the air vent (C) by means of an elbow.*

In this way, atmospheric pressure is maintained at the level of the vent (C) an consequently a uniform flow of solution is obtained irrespective of the height water in the tank. The effective head producing the flow is always equal to (H In order to prove that the flow is uniform, the outflow of each successive quart w timed just as described above but with the air-tight cap screwed down, and (wit the No. 150 disk in the union) every quart from the first to the 14th flowed out i just 37½ seconds.

*In a later model this stand-pipe is built inside the tank and is simpler in construction but the princip is the same.

Two other modifications of minor importance have been added. In the enlarged ase of the stand-pipe there is a float (M), which consists of a light hollow brass ylinder which has a "play" up and down of one inch. Attached to the top of this oat is a slender brass wire stem (N) passing up through the narrow part of the tand-pipe and projecting an inch above the top of it when the float is up, just even ith the top when the float is down. When the stream is running from the tank nd everything is in order, the float is down and the stem does not appear above the op. If, however, there is any leak in the top of the tank or the operator has for-otten to screw down the cap, *i.e.*, if the tank for any reason is not air-tight, the ater rises in the stand-pipe to the level in the tank, the float remains up and the rojecting stem warns the operator that something is wrong. The float is thus a afety device and not an absolutely essential part.

The second modification is a very small pipe (L) about two inches long inserted n the upper side of the outlet pipe. This was added when it was discovered that or each of certain intermediate disks there were two distinct rates of flow. If the ipe below the union became immediately filled with water when the stream was urned on, it continued to come out in a steady stream and we had the faster rate of ow. Under these conditions the effective head would be (P) in the diagram. But t other times, even with the same disk, air gained access to this pipe and the water ribbled out. Then we had the slow rate of flow due to the head (H). Either flow emained constant but one never knew when he opened the valve which speed he ould have. This difference in flow was eliminated when air was admitted to the utlet pipe through the small opening and pipe just mentioned.

With this improved tank just described all chances of error due to variation are liminated except one. Variation in the rate of application might arise from varia-ion in the speed at which the workman pushes the drill; *e.g.*, he might walk more lowly when he was tired or in softer land, etc. Numerous tests of the speed of ifferent workmen at various times have convinced the writers, however, that a ian's speed is remarkably constant and the error from this source is small. Never-ieless, it would be a distinct improvement if even this small error could be elimi-ated and the practical grower would be saved the trouble of measuring his speed nd calculating the disk which he should use. This could be done if the apparatus ere so constructed that the amount of solution delivered was proportionate to the istance travelled (*i.e.*, to the number of revolutions of the drill wheel) and not de-endent on the length of time during which the valve is open. Then the rate of pplication would be entirely independent of the speed at which the drill was pushed. uch a regulating apparatus, geared to the drill wheel, is mechanically possible and s construction has been planned at various times by the writers. The construc-on has been abandoned for various reasons but principally because it would be too omplicated and expensive and therefore less suitable for the average onion grower. or all practical purposes, and even for a fairly high degree of accuracy for experi-iental work, the apparatus described above is quite satisfactory.

MATERIALS OTHER THAN FORMALDEHYDE

One objection to the use of formaldehyde is the danger of injury to the seed nder certain soil conditions which have been discussed previously. Although this an be largely avoided by changing the formula of application to suit the soil con-ition, growers cannot always be depended on to attend to this and some losses from his source are inevitable. It would be much better if we had a substitute which ould give just as good control as formaldehyde, but without the attendant seed ijury. In a search for such a substitute the writers have experimented with a list f chemical preparations, including Kalimat, Pythal, Furfural, Semesan, Uspulun, ermisan and several disinfecting powders manufactured by the Du Pont Company nd by the Corona Chemical Division of the Pittsburgh Plate Glass Company. All f these were found to have some merit in decreasing the amount of smut, but for he most part the control was inferior to that secured by formaldehyde. Kalimat, owever, is a notable exception. It was tested for two years in the field and in the reenhouse in pots where the soil moisture was controlled. These experiments and he results are described in detail in a separate publication (3). It is sufficient here to present the data on the experiments of 1924 (Table IX, p. 29) and the concl sions from the results of the two years' experiments.

"In all tests during the last two years, kalimat has controlled onion smut just well as formaldehyde. It is superior to formaldehyde, however, not on account its fungicidal properties but on account of its comparative safety when used in co centrated solutions or when used in very dry soils. Under these same conditio formaldehyde frequently causes serious injury.

"The claim of the manufacturers that the percentage of germination is increas by the use of kalimat would seem at first to have some support in the data presente Of the 14 comparisons between treated and check rows, 10 show that there were mo seedlings on the treated than on the untreated rows. This does not necessari mean, however, that kalimat stimulated germination of the seeds; it may ha merely killed off some organisms which naturally destroy the seedlings before the reach the surface of the soil.

"The only objection to the use of kalimat is that it is rather expensive at presen It may be obtained for about $1.00 per pint. In larger quantities, however, could probably be obtained at a lower price. If any considerable demand for should be developed, the cost of production will be lowered or other substances en bodying the same protective principle will appear on the market.

"Of the formulas tried, probably the 1–50–4000 could be recommended as givir excellent control and as being economical of labor and material. This would requi about five quarts of kalimat per acre of onions when the rows are thirteen inch apart. In extremely dry soil the same amount applied in greater dilution migl have some advantage."

Uspulun. This is a patented German chemical preparation marketed in th form of a purplish gray powder, readily soluble in water to form a purple solutio The active fungicidal principle is orthochlorphenol. In preliminary greenhou experiments 1 per cent. and 2 per cent. were tried in the formulas 1–50–3000, 1–5 4000, 1–50–5000, 1–100–3000, 1–100–4000 and 1–100–5000. Fair control wa secured with all formulas but the best with 1–100–3000. In the field experimen of 1924 the formulas of 1–50–3000 and 1–100–3000 were each used on one row 7 feet long. The percentage of control was just as high as that secured by kalimat o formaldehyde. There was no evidence of seed injury or stunting and the percentag of germination was higher than on the check rows. The results were sufficientl promising to warrant the further testing of this substance. The results will b described more in detail after further tests under different conditions.

Germisan. This is also a German patented disinfectant marketed in the forr of a powder but to be used in solution. It has been tried only in our field experi ments of 1924 and in the formulas 1–50–3000, 1–50–4000 and 1–50–5000. All form ulas gave increased germination and good control of smut. The weakest formul gave just as good control as the others. These results look promising, but we hesi tate to make any recommendations until the material has been tried under othe conditions.

The other chemical solutions tried gave a percentage of control much lower tha formaldehyde.

Dry Chemicals. If some effective and comparatively cheap substance could b found which could be applied as a dry powder it would present certain advantage over solutions: (1) it would eliminate the labor of drawing barrels of water to th field, (2) it would make the drill easier to push because of elimination of the weigh of the water, (3) it would eliminate the danger of clogging the seed spout and pack ing wheel with mud, and (4) machinery for application would probably be simple and cheaper.

A number of these dry preparations have been tried by the writers but only on up to the present has given a high enough percentage of control to encourage furthe trials. This is a powder prepared especially for this kind of work by the Corona Chemical Division of the Pittsburgh Plate Glass Company and furnished to the writers under the label "Corona 640." In the preliminary greenhouse tests, this gave better control than any of the others and was, therefore, selected for the field tests of 1924. This was in badly infested soil but at the end of the season the row to which this material was applied contained as many healthy onions as any of the rows treated with the other preparations. There was also an increase in the number eedlings which came up. Further investigations are now in progress to determe whether the results will be repeated under different conditions and to perfect ple machinery for application.

LITERATURE ON ONION SMUT

ANDERSON, P. J. Development and pathogenesis of the onion smut fungus. Mass. Agr. Expt. Sta. Tech. Bul. 4:99–133. 1921.

ANDERSON, P. J. The relation of soil moisture to formaldehyde injury of onion seedlings. Phytopathology 13:392–403. 1923.

ANDERSON, P. J. Controlling onion smut with Kalimat. Phytopathology 14:569–574. 1924.

ANDERSON, P. J. Comparative susceptibility of varieties of onions and species of Allium to *Urocystis cepulae*. Jour. Agr. Res. (in press). 1925.

ANDERSON, P. J. and A. V. OSMUN. An improved formaldehyde tank for the onion drill. Phytopathology 13:161–168. 1923.

BARSS, H. P. Onion smut control. Oreg. Agr. Expt. Sta. Crop Pest and Hort. Rpt. (1915–20) 3:187–191. 1921.

CAPRON, HORACE. Diseases of the onion. U. S. Com. Agr. Rpt. (1869) 8:224. 1870.

CLINTON, G. P. North American Ustilagineae. Boston Soc. Nat. Hist. Proc. 31:329–529. 1904. (*U. cepulae* on p. 451).

COOKE, M. C. Onion smut. Gard. Chron. 7:634. 1877.

CORNU, M. Le charbon de l'oignon ordinaire (Allium Cepa), maladie nouvelle, originaire d'Amerique, causee par une Ustilaginee (*Urocystis Cepulae* Farlow). Compt. Rend. Acad. Sci. 89:51–53. 1879.

CORNU, M. Maladies nouvelles pour l'Europe, a propos d'une Ustilaginee (*Urocystis Cepulae* Farlow) parasite sur l'oignon ordinaire (Allium Cepa). Bul. Soc. Bot. France 26:263–267. 1879.

CORNU, M. Observations sur la maladie des oignons (*Urocystis Cepulae* Farlow). Bul. Soc. Bot. France 27:39–42. 1880.

COTTON, A. D. Onion Smut: A disease new to Britain. Jour. Eng. Bd. Agr. 26:168–174. 1919.

FARLOW, W. G. The onion smut. Abstract of returns of the agricultural societies of Mass. (published with Agr. of Mass. 24 (1876) but paged separately) :164–176. 1877.

FARLOW, W. G. Notes on some common diseases caused by fungi. Bul. Bussey Inst. 2:114 and 238. 1877.

FERNALD, H. T. and A. V. OSMUN. The control of onion diseases and thrips. Mass. Agr. Col. Ext. Circ. 5. 1916.

FRANK, A. B. Notiz uber den Zwiebelbrand. Bot. Centbl. 1:186. 1880.

GREGORY, C. T. The relation of rain to the formaldehyde treatment of onion smut. Phytopathology 12:155–156. 1922.

HALLIER, E. Der Brandpilz der Kuchenzwiebel, *Urocystis Cepae*. Wiener Illustrirte Garten-Zeitung 5:519. 1880.

HALSTED, B. D. Fungous disease of various crops. N. J. Agr. Expt. Sta. Rpt. (1890) 11:345–366. 1891.

HALSTED, B. D. Experiments with onions. N. J. Agr. Expt. Sta. Rpt. (1897) 18:300–302. 1898.

HALSTED, B. D. Artificial introduction of onion smut. Bul. Torrey Bot. Club 26:74. 1899.

HALSTED, B. D. Experiments with onions. N. J. Agr. Expt. Sta. Rpt. (1898) 19:319, 320. 1899. See also (1899) 20:392. 1900 and (1896) 17:352. 1897.

JAGGER, I. C. Diseases of vegetables. West. N. Y. Hort. Soc. Proc. 60:140–147. 1915.

JONES, L. R. Onion smut. Vt. Agr. Expt. Sta. Rpt. (1890) 4:141. 1891.

JONES, L. R. Investigation of plant diseases. Wis. Agr. Expt. Sta. Bul. 240:47. 1914. See also 250:36. 1915.

LIRO, J. IVAR. Ueber die Gattung Tuburcinia. Ann. Univ. Fenn. Aboensis Ser. A. T. 1, No. 1:1:153. Turku. 1922.

28. Magnus, P. Bemerkung zu A. B. Frank's Notiz uber den Zwiebelbra Bot. Centbl. 1:348. 1880.
29. Malbranche, M. Le Charbon des Oignons. Bul. Soc. Bot. France 28:277 1881.
30. Pammel, L. H. and C. M. King. Four new fungous diseases in Iowa. Io Agr. Expt. Sta. Bul. 131:216–220. 1912.
31. Phippin, George D. Report on the onion disease. Proc. Essex Inst. (18 2:207, 211–215. 1862.
32. Plant Dis. Bul. Crop losses from plant diseases, 1918. Sup. 6:210. 19
33. Proctor, J. W. An essay on the cultivation of the onion. Trans. Essex A Soc. (1847) :86–92. 1848.
34. Schroeter, J. Bemerkungen und Beobachtungen uber einige Ustilagine Cohn's Beitr. Biol. Pflanz. 2:349–383. 1877. (Polycystis Colchici p. 378–9).
35. Selby, A. D. Onion smut. Ohio Agr. Expt. Sta. Bul. 122:71–84. 1900
36. Selby, A. D. The prevention of onion smut. Ohio Agr. Expt. Sta. B 131:47–51. 1902.
37. Sirrine, F. A. and F. C. Stewart. Experiments on the sulphur-lime tre ment for onion smut. N. Y. (Geneva) Agr. Expt. Sta. Bul. 182:145–1 1900.
38. Sorauer, P. *Urocystis Cepulae.* Handbuch d. Pflanzenkrankheiten 2:3 1908.
39. Stone, G. E. The control of onion smut. Mass. Agr. Expt. Sta. Circ. 1915. Also Mass. Agr. Expt. Sta. Rpt. (1908) 21, Pt. 1:48, 49. 1909
40. Sturgis, W. C. Common fungous diseases and their treatment. Conn. St Agr. Expt. Sta. Bul. 111:14. 1892.
41. Sturgis, W. C. Diseases of the onion. Conn. State Agr. Expt. Sta. B 115:14, 15. 1893.
42. Sturgis, W. C. Transplanting as a preventive of smut upon onions. Co State Agr. Expt. Sta. Rpt. (1895) 19:176–182. 1896.
43. Taylor, Thomas. Onion blight and smut. U. S. Com. Agr. Rpt. (18 :193–195. 1874.
44. Thaxter, R. The smut of onions (*Urocystis cepulae* Frost). Conn. St Agr. Expt. Sta. Rpt. (1889) 13:129–153. 1890.
45. Thaxter, R. Further experiments on the smut of onions. Conn. State A Expt. Sta. Rpt. (1890) 14:103–104. 1891.
46. Vaughan, R. E. and J. C. Walker. Onion smut. Wis. Hort. 10:133–1 1920.
47. Walker, J. C. Onion diseases and their control. U. S. D. A. Farmers' B 1060:1–23. 1919.
48. Walker, J. C. Experiments upon formaldehyde drip control of onion sm Phytopathology 10:323–327. 1920.
49. Walker, J. C. Observations on the cultivation and diseases of cabbage a onions in Europe, 1922. Plant Dis. Reporter Sup. 32:1–33. 1924.
50. Walker, J. C. and L. R. Jones. Relation of soil temperature and other fa tors to onion smut infection. Jour. Agr. Res. 22:235–261. 1921.
51. Ware, Benj. P. Experience of a practical farmer. Abstract of returns of t agricultural societies of Mass. (published with Agr. of Mass. 17 (18 but paged separately) :10. 1870.
52. Whitehead, T. Experiments on the control of onion smut. Jour. Min. A Eng. 28:443–450. 1921.
53. Whitehead, T. On the life history and morphology of *Urocystis cepul* Trans. Brit. Myc. Soc. 7, Pt. 2. 1921.
54. Zillig, H. Ustilagineen in Sorauer's Handbuch d. Pflanzenkrankheit 4:298–299. 1923.
55. Zillig, H. Unsere heutigen Kenntnisse vom Zwiebelbrand (*Tuburcin cepulae* (Frost) Liro). Centbl. Bakt. (Abt. 2) 60:50–58. 1923.

TABLE I.

Cowls Farm Experiment, 1919

reatment ormula	100 Ft. of Row on June 2			100 Ft. Harvested September 15				Gain in Pounds per Acre
	Standing Onions	Per Cent. Smut	Total Gain in Healthy Plants	Number Onions Harvested	Gain in Bulbs	Weight in Pounds	Gain in Lbs.	
64–3200	2120	11.3	1222	773	596	105	66	26,400
96–3200	2256	12.8	1308	844	667	116	77	30,800
128–3200	1923	17.7	825	936	759	112	73	29,200
ntreated	1325	50.4		177		39		

TABLE II.

C. A. Clark Experiment, 1920

reatment Formula	Feet of Row Treated	Average Harvest for 100 Ft.				Gain in Pounds per Acre
		No. of Bulbs Harvested	Gain Over Check	Weight of Bulbs Harvested (Pounds)	Gain in Pounds Over Check	
-128–3000	1068	736	301	120	42	18,295
- 96–3000	1068	769	334	121	43	18,731
- 64–3000	1068	782	347	122	44	19,166
- 48–3000	1068	686	251	117	39	16,988
- 32–3000	534	758	323	125	47	20,473
- 50–4000	534	694	259	114	36	15,682
- 50–5000	534	615	180	108	30	13,068
ntreated	2136	435		78		

TABLE III.

Kuzmeski Farm Experiment, 1920

Treatment Formula	Feet of Row Treated	Average Harvest for 100 Ft.		Percentage of Increase
		Number of Bulbs Harvested	Gain in Bulbs Over Check	
1–96–3000	3488	849	493	137
1–50–5000	3488	610	254	72
Untreated	1744	356		

TABLE IV.

C. A. Clark Experiment, 1922

Treatment Formula	Percentage Methyl Alcohol	Feet of Row Treated	Average of 100 Feet		Percenta of Increas
			No. Bulbs Harvested	Gain in Bulbs Over Check	
1- 50-3000	6-14	2000	230	54	30
1- 50-3000	.4	1000	288	112	64
1- 50-3000	16.	1000	234	58	33
1- 50-4000	6-14	2000	238	62	35
1- 50-5000	6-14	2000	285	109	62
1- 64-3000	6-14	1000	268	92	53
1-128-3000	6-14	1000	303	127	72
Untreated		3000	176		

TABLE V.

Kuzmeski Farm Experiment, 1922

Treatment Formula	Feet of Row Treated	Average Harvest for 100 Feet		Percentag of Gain
		No. of Sound Bulbs	Gain in Bulbs Over Check	
1-50-3000	880	580	203	53
1-50-4000	880	576	199	53
1-50-5000	880	699	322	85
Untreated	880	377		

TABLE VI.

Allen Clark Farm Experiment, 1923

Treatment Formula	Feet of Row Treated	Average Harvest for 100 Feet		Percentage of Gain
		No. of Sound Bulbs	Gain Over Check	
1- 64-3000	1132	737	611	485
1- 75-3000	1132	733	607	482
1- 50-3000	1132	565	439	350
1-100-3000	1132	677	551	437
1- 50-4000	1132	721	595	472
1- 50-5000	566	339	213	169
Untreated	1698	126		

TABLE VII.

Kuzmeski Farm Experiment, 1923

'reatment Formula	Feet of Row Treated	Per Cent. Chemical Loss	Average Harvest on 100 Feet		
			No. of Sound Bulbs	Gain Over Check	Per Cent. Shrinkage June 1 to Sept. 3
- 50–3000	1744	57	299	– 8	29
- 50–4000	1744	51	262	–45	33
- 50–5000	1744	20	338	31	38
- 64–3000	872	41	285	–22	40
- 75–3000	872	32	356	49	35
-100–3000	872	36	314	7	36
'ntreated	2616		307		62

TABLE VIII.

College Farm Experiment, 1923

Treatment Formula	Feet of Row Treated	Per Cent. Chemical Loss	Per Cent. Shrinkage June 1—Aug. 30	Final Gain Over Check per 100 Feet
1– 50–3000	300	70	25	–31
1– 50–4000	300	49	39	23
1– 50–5000	300	30	33	95
1– 64–3000	300	72	28	63
1– 75–3000	150	60	31	7
1–100–3000	300	48	40	22
Untreated	975		73	

TABLE IX.

Comparison of Kalimat and Formaldehyde in the Field Tests of 1924 Each Row 70 Feet Long

Chemical	Formula	Number of Rows Treated	Average Number of Seedlings Which Came up per Row	Average Sound Onions Harvested per Row
Check		12	539	122
Kalimat	1– 50–5000	8	544	340
Formaldehyde	1– 50–5000	8	538	309
Kalimat	1– 50–4000	8	625	432
Formaldehyde	1– 50–4000	8	525	331
Kalimat	1– 50–3000	4	516	380
Formaldehyde	1– 50–3000	4	469	285
Kalimat	1–100–3000	4	593	331
Formaldehyde	1–100–3000	4	416	293

MASSACHUSETTS

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PERIMENTS ON THE CONTROL OF APPLE SCAB AND BLACK ROT AND SPRAY INJURY IN 1924

By W. L. Doran

is bulletin reports the results obtained, during the past season, in the study of the control of apple scab and black-rot. Incident to the main problems there have been comparisons of spraying and dusting, and observations on many related subjects. The difficulty which led to such widespread injury from apple scab, previous to the initiation of this work in 1921, was in the spray calendar, particularly with reference to the prepink and pink sprays or dusts. Greater care in these applications seems to be absolutely essential in any thoroughgoing attempt to control this destructive disease.

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AGRICULTURAL EXPERIMENT STATION
AMHERST, MASS.

EXPERIMENTS ON THE CONTROL OF APPLE SCAB AND BLAC ROT AND SPRAY INJURY IN 1924.*

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The experiments of 1924† were planned with the object of securing furth data on the comparative efficiency of several materials and schedules in co trolling apple scab caused by *Venturia inaequalis*. In addition to this, so attention was given to black-rot caused by *Physalospora cydoniae,* with a vi to increasing our knowledge of its economic importance, seasonal occurren and control in Massachusetts. Data were also secured which, it is believed, w assist orchardists in reducing the severity of spray injury on fruit and folia

Materials and Methods.

At Middlesex Fruit Farm, Gravensteins having a spread of about 35 feet a a height of about 25 feet were sprayed, and Baldwins having a spread of abo 30 feet and a height of about 25 feet were dusted. At both Harvard Fruit Fa and Pine Crest Orchard only McIntosh trees were used. At the former orcha these trees are eight years old and about 15 feet in height and diameter, and the latter orchard they are 11 years old and larger in proportion.

At Harvard Fruit Farm and Pine Crest Orchard, Friend sprayers were us with a pressure of about 200 pounds. At Middlesex Fruit Farm an Arlingt X L Sprayer was used with a pressure of about 150 pounds. At Middles Fruit Farm two spray rods were used. Spray guns were used at Pine Cr Orchard and at Harvard Fruit Farm, two at the former and one at the latt

At Middlesex Fruit Farm liquid lime-sulfur, 1 gallon in 50 gallons, was use and in the other orchards dry lime-sulfur, 4 pounds in 50 gallons, was used.

Lead arsenate was present in all sprays or dusts in the usual proportions f the pink and calyx applications and for the application about two weeks aft the calyx.

The Bordeaux mixture used was of the 3-10-50 formula.

Dry-mix sulfur-lime was made up to contain 8 pounds of sulfur, 4 pounds hydrated lime, and ½ pound of calcium caseinate in 50 gallons of spray, described by Farley.**

The copper dust used contained 11 per cent monohydrate copper sulfate. T sulfur dust used contained 90 parts or 85 parts sulfur, and 10 parts or 15 par lead arsenate in 100 parts. Niagara Sulfo-dust without arsenic was used f all applications except those specified above as receiving an arsenical.

The dusting was done with Niagara power dusters. In dusting, the halves the application were not "split," that is, at each application each tree w dusted from two sides. The dusting was done either early in the morning or the evening, in order to have the foliage moist and to avoid wind.

Two McIntosh orchards were dusted and two McIntosh orchards were spraye An orchard of Gravensteins was sprayed and an orchard of Baldwins was duste

All plots were sprayed or dusted at least four times. The dates of applic tions were as follows in the McIntosh orchards: prepink, May 5-7; pink, Ma 14-17; calyx, May 31—June 2; fourth, June 11-16; fifth spray, July 14; fift dust, June 30—July 1; sixth dust, July 14-15; seventh dust, August 9-11. O the other varieties, the applications were made at about the same time, althoug in the case of the preblossom and calyx applications, the Gravenstein orchar received treatment a few days before the McIntosh, and the Baldwins a few day after the McIntosh.

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* *Acknowledgment.* This work was done with the co-operation of the Nashoba Fru Producers' Association, in the following orchards: Mr. Albert Jenks' Middlesex Fru Farm, West Acton; Mr. Stephen W. Sabine's Pine Crest Orchard, Groton; and M Philip H. Babcock's Harvard Fruit Farm, Harvard. In scoring the fruit, assistance wa given by Professors A. I. Bourne, B. D. Drain, J. S. Bailey, and W. H. Thies of Massach setts Agricultural College. Mr. W. P. Wharton furnished rainfall records.

† For results of earlier experiments in Massachusetts, see: Mass. Agr. Expt. Sta. Bu letins 214 and 219.

** Farley, Arthur J. Dry-mix sulfur lime. New Jersey Agr. Expt. Sta. Bul. 379. 192

Relation of the Weather to Infection and to Disease Severity.

There was rain on nineteen days in May, and ascospores were ejected on each these days. The combination of rain, viable ascospores, and susceptible host sue resulted in a condition most favorable to scab infection. In 1924, ascoores were mature and beginning to be discharged earlier with reference to the ndition of apple bud development than in 1923. In Baldwin orchards where spray was applied before the pink application considerable primary infection s permitted.

The precipitations for June and July were below the normals for these nths. Rain fell on eleven days in June and on seven days in July. As a ult of the dry summer, scab control was not difficult, and the year was characized by scab infestation of average rather than exceptional severity. This uld seem to indicate that rainy weather before and during the period of wering may not have any greater influence on the percentage of scabby ples at picking time than has the rainfall of the summer.

Not more than 7.0 per cent of the fruit on any check plot developed black-. The rarity of black-rot and frog-eye leaf spot was presumably the result the relative dryness of the weather in June and July, for the rainfall was undant in May and was not below normal in August.

Scab Infection on Leaves.

On June 9, after the trees had received prepink, pink and calyx applications, essible leaves were scored for scab lesions. This was only ten days after first scab infection of the season was found, and the count therefore gives a very fair indication of the relative success of the several treatments in eventing the primary infection. The results are given in Table I.

In all orchards there was somewhat less scab on trees dusted with copper-limeenic dusts at the prepink and pink applications than on trees dusted with fur. This difference, it should be added, practically disappeared later in the son.

There was at this time less scab infection on the leaves of sprayed trees than the leaves of dusted trees, due probably to the more rapid removal of the st by the frequent rains in May.

Lime-sulfur solution (with or without spreader), Bordeaux mixture and dryx sulfur-lime were practically equally successful in preventing the primary ection.

Set of Fruit as Affected by Scab and by Fungicides.

Scab infection on pedicels resulted in the early fall of many flowers and young its on check trees at the Harvard Fruit Farm. Flowers were counted on rked limbs in each plot at this orchard, and on June 30 the fruits which had on these limbs were counted. In sprayed or dusted plots from 3.0 to 5.0 per t of the flowers had set fruit and on check trees from 0.9 to 1.5 per cent of flowers had set fruit. The fungicides, by preventing pedicel infection, reased the set of the fruit.

Control of Scab on the Fruit.

These results are given in Table II. In considering scab control, it is first all necessary to take into account the degree of scabbiness of fruit on check es. The percentages of scabby fruits on check trees in the several orchards re as follows:

Pine Crest Orchard	(check for sprayed plots)	69.4
Pine Crest Orchard	(check for dusted plots)	45.8
Harvard Fruit Farm	(check for sprayed plots)	81.0
Harvard Fruit Farm	(check for dusted plots)	84.2
Middlesex Fruit Farm	(check for dusted plots)	50.2

Results in the sprayed plots.—Four applications of lime-sulfur solution with- spreader may be regarded as the standard treatment. With this treatment Pine Crest Orchard there was 1.2 per cent scabby fruit, and at Harvard Fruit rm, 0.2 per cent scabby fruit. This adds to the evidence, already abundant, ne-sulfur is a dependable fungicide against apple scab.

in the Baldwin orchard was there enough black-rot to enable us to secure information as to relative efficiency of the several treatments in control this disease. In this orchard 7.2 per cent of the fruit on check trees, 2.0 cent of the fruit on the plot dusted with copper dust followed by sulfur d and an average of 0.9 per cent of the fruit on all plots dusted with sulfur showed black-rot infection. The infection on the check was of course light, we have some indication of the protection against black-rot given by the treatment.

Cost of Dusting and Spraying.

This includes the cost of materials and the cost of labor, but not the cos equipment. The cost of treatment for one tree for the season is given in T IV.

The labor involved was performed by two men and two horses at orchard, except Middlesex Fruit Farm where but one horse was used. Fur details as to size of trees and labor are given under the section on "Meth and Materials."

On the Gravensteins of the Middlesex Fruit Farm, 690 gallons of liquid seven hours of labor were required to spray 100 trees. To dust 100 Bald here required 50 minutes and 127 pounds of sulfur dust. At Harvard F Farm, 100 trees were sprayed in two hours, using 160 gallons of liquid. hundred trees of this size were dusted in 33 minutes, using 75 pounds of su dust. At Pine Crest Orchard, 100 trees were sprayed in two and three-fou hours, using 360 gallons of liquid. One hundred trees at this orchard dusted in 35 minutes, using 110 pounds of sulfur dust.

Although liquid lime-sulfur was not used at Harvard Fruit Farm or Crest Orchard, it is also included in the record of costs for purposes of parison.

A study of Table IV makes it evident that our cheapest method of pro tion is to spray with liquid lime-sulfur. Dry-mix sulfur-lime is more expen although the difference is not so great if dry rather than liquid lime-su is considered. Bordeaux mixture is intermediate in cost between dry and li lime-sulfur. Use of the spreader necessarily increases the cost.

As to whether spraying or dusting is cheaper depends on the facilities spraying, the distance from the water supply, the size of the spray tank, size of the trees, and how many applications of dust are considered necess Five applications of dust were enough in 1924. This being the case, it as cheap to protect by dusting as by spraying at Middlesex Fruit Farm. the other two orchards, with smaller trees and less time spent in going water, protection proved somewhat cheaper by spraying than by dusting, vided that our cheapest spray material is considered.

In most orchards where dry lime-sulfur and spreader is to be used, i probable that the cost will not be far from that of dusting.

Summary.

The primary infection of the leaves was prevented equally well by lime-sul Bordeaux mixture, and dry-mix sulfur-lime. The primary infection of leaves was prevented more completely by spraying with lime-sulfur than dusting with sulfur.

The prevention of pedicel infection by the fungicides improved the set fruit.

On McIntosh plots sprayed with lime-sulfur four times, there were 1.2 cent and 0.2 per cent scabby apples; while on their respective check plots t were 69.4 per cent and 81.0 per cent scabby apples.

The addition of calcium caseinate spreader to lime-sulfur-lead arsenate sp did not result in increased protection against scab.

A fifth application of lime-sulfur did not increase the protection agai scab afforded by four applications. The necessity for a late application scab control is probably affected less by the rainfall of August than by degree of scabbiness attained by the tree in June and July.

Dry-mix sulfur-lime did not control scab on McIntosh as completely as lime-sulfur.

The substitution of Bordeaux mixture for lime-sulfur for the prebloss ıpplications gave practically perfect protection against scab, but the use of ime-sulfur for all applications gave protection which was essentially as good.

Sulfur dust gave satisfactory control of scab. In McIntosh orchards there was an average of 3.5 per cent scabby apples on plots dusted with sulfur, while on the check plots there was an average of 65.0 per cent scabby apples. No proof was secured that it is necessary to substitute copper dust for sulfur dust for the preblossom applications.

Lime-sulfur-lead arsenate spray caused foliage injury, and this was not prevented by the addition of calcium caseinate spreader. Leaves on trees dusted with sulfur or sprayed with dry-mix sulfur-lime were not visibly injured.

The addition of calcium caseinate spreader to lime-sulfur-lead arsenate spray resulted in a reduction of about 50 per cent in the amount of russeted fruits in Gravensteins.

There was a larger percentage of russeted apples on plots on which Bordeaux mixture or copper dust was used for preblossom applications than on plots sprayed with lime-sulfur or dusted with sulfur at all applications.

In the Baldwin orchard, there were three times as many leaves with frog-eye leaf-spot on check trees as on trees dusted with sulfur. In this orchard, 7.2 per cent of the fruit on check trees became infected with black-rot and the disease was present on 0.9 per cent of the fruit dusted with sulfur.

The costs of various treatments are recorded and compared. The costs of spraying and of dusting are not very far apart.

TABLE 1.—SCAB ON LEAVES

Variety*	† Treatment	Per cent Scab
Baldwins	Check	24
	Copper dust, prepink and pink; sulfur dust at calyx application	7
	Sulfur dust	11
McIntosh	Check	27
	Copper dust, prepink and pink; sulfur dust at calyx application	8
	Sulfur dust	14
McIntosh	Check	45
	Sprayed with Bordeaux, prepink and pink; calyx application of lime-sulfur	1
	Sprayed with lime-sulfur-lead arsenate, without spreader	1
	Sprayed with lime sulfur-lead arsenate with spreader	1
	Sprayed with dry-mix sulfur-lime	2
McIntosh	Check	30
	Copper dust, prepink and pink; sulfur dust at calyx application	4
	Sulfur dust	7
McIntosh	Check	34
	Sprayed with Bordeaux, prepink and pink; calyx application of lime-sulfur	1
	Sprayed with lime-sulfur-lead arsenate, without spreader	1
	Sprayed with lime sulfur-lead arsenate with spreader	1
	Sprayed with dry-mix sulfur-lime	3

*Separate orchards indicated by brackets.
†Up to June 9, through calyx application.

TABLE II.—SCAB CONTROL.

(Fruit counts in August, September and October, at picking time.)

Treatment	Number of Applications	Per cent Scabby Fruit		
		Baldwins Middlesex Fruit Farm	McIntosh Pine Crest Orchard	McIntosh Harvard Fruit Farm
Check for sprayed orchards	None		69.4	81.0
Lime-sulfur without spreader	Four		1.2	0.2
Lime-sulfur with spreader	Four		2.4	
Lime-sulfur without spreader	Five		0.2	0.0
Lime-sulfur with spreader	Five			2.4
Dry-mix sulfur-lime	Four			3.5
Dry-mix sulfur-lime	Five		8.8	
Bordeaux, prepink and pink; followed by lime-sulfur	Four			0.0
Bordeaux, prepink and pink; followed by lime-sulfur	Five		0.1	
Check for dusted orchards	None	50.2	45.8	84.2
Sulfur dust	Four	9.2	1.5	5.4
Sulfur dust	Five	4.7	2.3	3.3
Sulfur dust	Six	8.5	3.1	3.8
Sulfur dust	Seven	5.3	6.0	2.8
Sulfur dust (average of plots)	Four to Seven	6.9	3.2	3.8
Copper dust, prepink and pink; followed by sulfur dust	Five	7.3	1.2	2.4

TABLE III.—SPRAY INJURY.

Russeting of Fruit.

Treatment	Number of Applications	Per cent of Fruit Russeted			
		Middlesex Fruit Farm		Pine Crest Orchard McIntosh	Harvard Fruit Farm McIntosh
		Gravenstein	Baldwin		
Check for sprayed orchards	None	2.7		0	0
Lime-sulfur-lead arsenate spray:					
Without spreader	Four	16.0		0.8	0.4
With spreader	Four	8.4		0.9	
Without spreader	Five			0.6	0.8
With spreader	Five	9.0			0.9
Dry-mix sulfur-lime-lead arsenate spray	Four				0.9
Dry-mix sulfur-lime-lead arsenate spray	Five	4.6		0.3	
Bordeaux mixture, prepink and pink; followed by lime-sulfur-lead arsenate spray:					
With spreader	Four	13.1			13.5
Without spreader	Five			14.7	
Check for dusted orchards	None		0.4	0.5	0
Sulfur dust	Four		2.3	1.6	0
Sulfur dust	Five		2.2	0.9	0.8
Sulfur dust	Six		1.3	0.5	1.0
Sulfur dust	Seven		4.8	0.3	0.6
Sulfur dust (average of plots)	Four to Seven		2.2	0.8	0.6
Copper-lime-arsenic dust, prepink and pink; followed by sulfur dust	Five		4.0	11.1	5.0

TABLE IV.—COST PER TREE.

Treatment	Number of Applications	Middlesex Fruit Farm	Pine Crest Orchard	Harvard Fruit Farm
Lime-sulfur without spreader	Four		$.33* .26†	$.19* .16†
Lime-sulfur with spreader	Four	$.56†	.35* .29†	
Lime-sulfur without spreader	Five	.60†	.39* .31†	.19†
Lime-sulfur with spreader	Five	.67†		.20†
Dry-mix sulfur-lime	Four		.38	.20
Dry-mix sulfur-lime	Five	.81		
Bordeaux mixture, prepink and pink; followed by lime-sulfur with spreader	Four	.63†		
Bordeaux mixture, prepink and pink; followed by lime-sulfur without spreader	Four		.31†	.17†
Sulfur dust	Four	.48	.30	.25
Sulfur dust	Five	.56	.35	.29
Sulfur dust	Six	.64	.39	.33
Sulfur dust	Seven	.72	.44	.37
Copper dust, prepink and pink; followed by sulfur dust	Four	.50		
Copper dust, prepink and pink; followed by sulfur dust	Five		.36	.33

* Dry lime-sulfur. † Liquid lime-sulfur.

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MILK SUBSTITUTES IN THE REARING OF YOUNG CALVES

By J. B. Lindsey and J. G. Archibald

Dairy farms located adjacent to their market, as are most of those in Massa- c usetts, usually find it more profitable to sell fluid milk than to sell cream a l use the skim milk in growing young stock. The relatively high price c fluid milk has been an incentive to better the grade of stock kept on our d ry farms, while the same cause has made it unprofitable to rear calves from t s high grade stock. Unless a substitute for milk, to be used in rearing c ves, can be found, one of the great advantages of high grade producing s ck on our dairy farms cannot be realized. It was to meet this need that t work here reported was initiated. The bulletin presents the report of seven d ferent feeding trials with forty-five different animals.

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MILK SUBSTITUTES IN THE REARING OF YOUNG CALVES.

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Introduction.

The problem of rearing calves for the first four to six months of their lives thout the liberal use of whole or skim milk has been studied by many agri-ltural investigators. Where plenty of whole and skim milk are available is a relatively simple matter, provided one understands the technique of calf aring, which includes cleanliness in care and feeding and close observation prevent overfeeding. Much depends on the calf itself; some are thrifty d require but little attention, while others are delicate and finicky, and re-ire constant attention and considerable skill to bring them through their byhood.

In the three southern New England states most of the product of the dairy rd is sold as whole milk, hence very little of either whole or skim milk is ailable for feeding purposes. In northern New England, where creameries e still in operation and skim milk and pasture are available, large numbers dairy cows should be raised to supply the needs of the dairymen farther uth. Even were this practice followed to a greater extent than it is at esent, dairymen could still be found throughout southern New England de-ous of raising more or less of their own stock. They have been and are ll confronted with the difficulty of finding a suitable substitute for the rel-ively expensive milk.

It is not the intention in this publication to review in detail the work of e many investigators who have studied the problem, but rather to state iefly the different types of substitutes that have been fed and the results cured, and in addition to give a brief summary of our own more recent study the subject.

In most of the older investigations reported, skim milk was used extensively, pplemented with numerous substances such as cod liver oil, coconut oil, xseed jelly, starch, rolled oats, etc. Some form of oats, either crushed, rolled, nole, or oat meal, seems to have been the most universal supplement and to ve given the best results. The problem, however, with skim milk unavailable to find some substitute that will take its place and produce thrifty calves.

The substitutes used in more recent studies can be grouped under four gen-al heads:

1. Calf meals compounded from cereal grains, oil seeds and oil cakes, and guminous seeds.
2. Meals similar to those in (1) supplemented with such animal proteins blood flour and skim-milk powder.
3. Manufactured milk by-products, such as skim-milk powder, malted milk sidue, semi-solid buttermilk and buttermilk powder.
4. Infusions of clover hay, of flaxseed, and of such meals as bean meal and nseed oil meal.

The feeding trials with these various mixtures have been carried on at wide separated points, under varying conditions and in many cases with an insuf cient number of animals; so that it is not possible to state positively whi type of substitute has given the most satisfactory results. The success of t different types as measured by daily gain in weight of the calves has vari from fair to excellent, largely due, no doubt, in most instances, to differenc in the vigor of the individual calves. In general fair growth has been pr duced, the average being about a pound to a pound and a quarter daily. T few trials that have been made with the materials in Group 3 indicate th they are more suitable for calves up to six or eight weeks of age than a meals made from grains. Considering their source this is what would natural be expected. In Groups 1 and 2 linseed meal and some form of oats see to have been universally used. Obviously no statement as to comparative co can be made. That depends on current prices and materials locally availab

Recent Experiments at this Station.

Our own more recent investigation of the problem commenced in the f of 1921, and is still in progress. This article reports results up to Ju 1924, at which time seven different substitutes had been given a trial and fort five calves had been more or less successfully raised.

In formulating our substitutes the following essentials have been taken i consideration:

1. Variety and completeness of protein.
2. Sufficient carbohydrate to balance the ration satisfactorily.
3. Plenty of vitamines.
4. Sufficient mineral matter.

Method of Feeding.

Our method of feeding has been planned so as to have the calves wean from whole and skim milk as early as possible. The calves are left with th dams only twenty-four hours, at the end of which time they are taught to dri whole milk from a pail. The milk fed to them is always from one of t lowest testing Holstein cows in the herd, and the maximum fed is six qua daily. When the calf is a week to ten days old the whole milk is gradual replaced by skim milk. If it is a vigorous animal it will be receiving ski milk entirely by the end of the second week. When the calf is from two three weeks old the skim milk is gradually replaced, a quart at a time, by gruel made from the meal which it is desired to give a trial. The gruel made by mixing the meal with water in the proportion of 3½ ounces of me to each quart of water. It is stirred up with a little cold water first so lum will not form, and then the correct amount of warm water is added, and t gruel fed at blood heat, never cold or very hot. Skim milk, while it continu to be fed, is mixed with the gruel at feeding time. By the time the calf a month old it is receiving only two or three quarts of skim milk daily a this is gradually withdrawn so that before it is two months old it is wean from milk entirely. Ten quarts of liquid is the average maximum fed.

This schedule cannot be blindly adhered to, because calves differ greatly their individual appetites and ability to stand the changes in feed, but it serv as a general guide. The calves have been taught to eat rowen and dry gra as early as possible. Most of them have learned to eat these feeds at abo four to five weeks of age.

The feeding trials have in every instance been discontinued at four mont of age as it is considered that by that time the critical period of the calf's e istence has been passed. All calves have been weighed weekly and their pro ress carefully noted.

The calf meals have been mixed as needed in one hundred pound lots and refully sifted to remove all lumps and foreign material. A detailed account the nature of the various substitutes and the results obtained with each, is ven in the following pages. A summary of the work appears on page 49 .

lf Meal No. 1, composed of:

Ground rolled oats	45 lbs.
Soluble blood flour	20 "
Linseed meal	10 "
Corn starch	14 "
Corn sugar	5 "
Alfalfa flour	5 "
Calcium chloride	½ "
Salt	½ "
Total	100 lbs.

The chief source of protein in this meal was soluble blood flour, a high grade oduct, readily soluble in water, specially prepared for animal feeding by United Chemical and Organic Products Company of Chicago. The rolled s and linseed meal were used because experience has shown that they are great value in calf feeding. The starch and sugar furnished a large part the carbohydrate of the ration, and in addition the sugar gave the meal a eet taste. Alfalfa flour was included as a desirable source of vitamines and otein. Calcium chloride furnished additional calcium in a readily soluble m.

Seven calves were raised on this meal, a group of four during the winter of 21-22, and another group of three in 1924. The first group made an average ly gain of 1.25 pounds, and required 284 pounds of dry feed for 100 pounds gain. Strangely enough the second group did not do nearly so well, making average daily gain of 0.57 pound and requiring 494 pounds of dry feed 100 pounds of gain. Two of them (Nos. 73 and 74) made so little growth l were so unthrifty that at three months of age they were changed over Meal No. 6 (see page 47 for composition of this meal) to see if it would oduce any more favorable results. No. 73 responded at once and made an rage daily gain of 1.28 pounds during the fourth month of his life, as compared with 0.42 pound daily gain previous to the change. No. 74 did not pond at all and had to be put on a skim-milk diet to save him. No reason er than individual vigor of the calves can be assigned for the great difference in the two groups. With one possible exception all of them were strong hearty when dropped. The figures for the whole lot are: average daily n—0.96 pound; dry feed required for 100 pounds of gain, 374 pounds.

f Meal No. 2 consisted of:

Ground rolled oats	45 lbs.
Skim-milk powder	20 "
Linseed meal	10 "
Corn starch	14 "
Corn sugar	5 "
Alfalfa flour	5 "
Calcium chloride	½ "
Salt	½ "
Total	100 lbs.

his meal was similar to Meal No. 1 except that its chief source of protein third grade skim-milk powder obtained from the Merrell-Soule Company, acuse, New York. Four calves were raised on it and all made good growth, average daily gain being 1.19 pounds; dry feed required for 100 pounds gain—316 pounds.

Calf Meal No. 3, composed of:

Ground rolled oats	35 lbs.
Soluble blood flour	5 "
Skim-milk powder	15 "
Linseed meal	10 "
Corn starch	19 "
Corn sugar	5 "
Alfalfa flour	10 "
Calcium chloride	½ "
Salt	½ "
Total	100 lbs.

This meal combined the chief protein sources of Meals 1 and 2; also t starch and alfalfa flour were increased five pounds each, the rolled oats bei reduced ten pounds. This change was made for two reasons, (1) it was thoug that the alfalfa flour constituted an excellent source of vegetable protein, vitamines, and of ash, and (2) for the sake of economy. At the time the me was formulated rolled oats was selling for four cents a pound while star was less than two cents a pound and alfalfa flour was two and a half cen

Four calves were raised on this meal; two others did not thrive on it at and it was deemed best to dispose of them. Of the four raised, two did re sonably well and the other two made very poor growth. The average dai gain was 0.77 pound and the dry feed required for 100 pounds of gain w 349 pounds. It is evident that this meal was not suitable as a skim-milk su stitute. Thinking that the trouble might have been due to the increase amount of alfalfa flour, this ingredient was cut down to five pounds, t amount used in Meals 1 and 2, and the rolled oats increased to forty poun The corn sugar was discontinued and five more pounds of corn starch su stituted for it. The meal, which was designated as Calf Meal No. 3 (modifiec then consisted of:

Ground rolled oats	40 lbs.
Soluble blood flour	5 "
Skim-milk powder	15 "
Linseed meal	10 "
Corn starch	24 "
Alfalfa flour	5 "
Calcium chloride	½ "
Salt	½ "
Total	100 lbs.

Three calves were raised on this modification of Meal No. 3. They ma slightly better growth than did those on the original meal, but required co siderably more food for an equal amount of gain. The average daily ga was 0.89 pound, and the dry feed required for 100 pounds of gain was 3 pounds.

Calf Meal No. 4 was composed of:

Ground rolled oats	14 lbs.
Soluble blood flour	10 "
Skim-milk powder	10 "
Linseed meal	10 "
Coconut meal	10 "
Peanut meal	10 "
Milk sugar	30 "
Alfalfa flour	5 "
Calcium chloride	½ "
Salt	½ "
Total	100 lbs.

The principal difference between this meal and the preceding ones is in the urce of the carbohydrates. In an attempt to more closely resemble milk, ilk sugar was substituted for all of the starch and part of the rolled oats. lso ten pounds each of coconut and peanut meal were included to give a gher fat content and in the case of coconut meal to supply more of Vitanes "A" and "D."

Four calves were raised on this meal and, taking into consideration the fact at three of them were delicate to begin with, they made very fair growth, e average daily gain being 0.99 pound, and the dry feed required for 100 unds of gain being 303 pounds. At prevailing prices of milk sugar this al was too expensive, but it indicated possibilities which should not be disgarded.

lf Meal No. 5:

This meal was not prepared to feed as a gruel, but as a dry grain for the ntrol lot of calves which received skim milk, and was not consumed in any antity until they were 5 to 6 weeks old. It was also fed as dry grain for o lots of calves that received modified skim milk as the liquid portion of ir diet. It was composed of:

Ground whole oats (not rolled)	30 lbs.
Flour middlings	20 "
Corn meal	19½ "
Linseed meal	10 "
Coconut meal	10 "
Peanut meal	10 "
Salt	½ "
Total	100 lbs.

Results secured in feeding this meal will be discussed under the heading of m milk and modifications of skim milk.

lf Meal No. 6:

This meal was formulated as a result of our experience with the other meals r a period of two years. It consisted of:

Ground rolled oats	20 lbs.
Soluble blood flour	10 "
Skim-milk powder	10 "
Corn starch	19 "
Red dog flour	15 "
Linseed meal	10 "
Coconut meal	10 "
Alfalfa flour	5 "
Calcium chloride	½ "
Salt	½ "
Total	100 lbs.

is in many respects similar to Nos. 1, 2 and 3. Red Dog flour was subted for a portion of the rolled oats for considerations of economy and nake a little more variety. Coconut meal was included for the same reason n Meal No. 4. Peanut meal was not included because of difficulty in obing it.

ix calves were raised on this meal. None of them made very good growth irst. Later four of them did very well, but two of them (67 and 68) coned to do so poorly and refused so much of their feed that it was decided emove from the meal for these two, the coconut meal, which it was thought ht be the particular ingredient they objected to. After this change they e somewhat better growth. The average daily gain for all six was 1.02

pounds, and the dry feed required for 100 pounds of gain averaged 326 pounc As already noted (p. 45) Calf No. 73 when changed from Meal No. 1 to tl meal showed a marked improvement in growth.

Skim Milk.

As a standard with which to compare results from our numerous substitu skim milk was fed to six calves. The maximum amount fed to any one ca was 12 quarts daily. The calves were all weaned to skim milk during t second week of their lives, except that two quarts of whole milk were giv daily until eight weeks of age in order to supply a little milk fat. Additior mineral matter was supplied in the form of mineral mixture No. 1 (one pa by weight, salt, to two parts calcium carbonate), three grams of this mixtu being added to each quart of skim milk fed. The calves were taught to e dry grain in the form of Meal No. 5 when about 4 to 5 weeks of age.

All six calves made excellent, some of them phenomenal growth, which w to be expected. The average daily gain was 1.68 pounds; one calf made da gains of over two pounds. The amount of dry feed required for 100 poun of gain was 251 pounds.

Skim-milk powder and corn starch.

The dried milk industry has of recent years developed very rapidly. A cording to Hunziker* there were forty-seven concerns producing skim-m powder in the United States in the year 1919, and their total output was ov thirty-three million pounds. A considerable quantity of the output is so-call "third grade," unsuited for domestic or bakers' consumption but suitable f animal feeding. This can be had at a reasonable price and as it solves t transportation and storage problems of liquid skim milk its value for c feeding is worthy of thorough study. As already noted we have used mo or less of it in all our formulae, as high as 20 per cent in Meal No. 2. Duri the summer of 1923 a somewhat different method of feeding it was given trial.

A gruel consisting of two parts of skim-milk powder to one part of co starch was fed to seven calves, the maximum amount to any one calf bei nine quarts of the gruel. The corn starch was added to the milk in order widen the nutritive ratio, and thus protect the protein from being used as source of energy.

The weaning procedure and other details were identical with those follow for the calves raised on Meals 1 to 6 except that two quarts of whole mi were fed daily until the calves were eight weeks old. The dry grain for t lot and the next one was Meal No. 5. The gruel was prepared in the followi manner:

3½ ounces skim-milk powder
1¾ ounces corn starch
1/10 ounce mineral mixture No. 2 (equal parts by weight salt and calcium carbonate)
1 quart water.

The skim-milk powder and starch having been weighed out beforehand, t necessary amount of cold water was measured out and the starch stirred in it slowly and carefully, care being taken to have all lumps broken up. T starch and water mixture was then heated slowly and with constant stirri to a temperature about 170°-175° Fahrenheit, but not higher than 175° Fa renheit. The mixture was then cooled to 140° Fahrenheit and the skim-m powder and mineral mixture slowly stirred in. When the gruel had cool to blood heat it was ready to feed. This method of preparation insured uniform gruel free from lumps, and the solids did not settle out on standin Several gallons of the mixture were made up at one time and it kept we being quite sweet twenty-four hours after mixing if kept cool. The calv

*Otto F. Hunziker, Condensed Milk and Milk Powder, 3d edition, 1920, p. 278.

rank the gruel readily and although they had some digestive disturbance in he form of scours this was not any more marked, nor as much so as in the ase of many of those raised on the different meals. All of them made good rowth, notwithstanding the fact that four of them were delicate at birth. he average daily gain was 1.34 pounds and the dry food required for 100 ounds of gain was 280 pounds.

iquid skim milk and starch.

In order to check the skim-milk powder against liquid skim milk, a second t of four calves was fed on a gruel prepared in a manner similar to the bove except that liquid skim milk was used, the starch and mineral mixture eing stirred into the skim milk which was then heated to about 150° Fahrenheit, not higher. All the calves made very good growth, the average daily ain being 1.35 pounds, and the dry feed required for 100 pounds of gain as 277 pounds, results almost identical with those obtained in feeding the kim-milk powder and starch. This would indicate that skim-milk powder in be successfully substituted for the liquid article.

The question was raised as to whether the calves could readily assimilate e starch added to the skim milk. The good growth secured with both lots calves (eleven in all) indicates that they were able to utilize it quite well. ests for starch were made on their droppings. In only two instances was y found, and both of these were delicate calves at birth.

The accompanying table summarizes the results which have been given in tail in the foregoing pages.

SUMMARY OF GAINS PRODUCED ON VARIOUS SKIM-MILK SUBSTITUTES

laterial	Number of calves	Average daily gain in live weight	Average amount dry feed for 100 lbs. gain	Cost of food per 100 lbs. of gain	Food cost to 4 months of age	Cost of one quart of gruel	Cost of 100 lbs. of dry calf meal	Remarks
		Lb.	Lbs.			Cts.		
Ca Meal No. 1....	7	0.96	374	$15.39	$22.56	1.6	$6.30	{ 1st lot did well 2d lot did very poorly
Ca Meal No. 2....	4	1.19	316	14.39	20.58	1.3	5.10	Made good growth
Ca Meal No. 3....	4	0.77	349	16.55	15.72	1.4	5.40	Did not grow very well
Ca Meal No. 3, odified	3	0.89	381	18.17	19.80	1.4	5.40	Slightly better gains than those on Meal 3
Ca Meal No. 4....	4	0.99	303	22.67	27.19	2.4	9.90	Made very fair gains
Ca Meal No. 6....	6	1.02	326	15.62	19.32	1.3	5.10	Made very fair gains
Sk milk heck lot)	6	1.68	251	(14.29* (16.91†	28.54	1.6‡	....	Excellent growth
Sk milk and rch	4	1.35	277	17.67	29.25	2.0‡	....	Very good growth
Sk milk powder d starch	7	1.34	280	20.32	33.38	2.5‡	....	Very good growth

With skim milk at 1½ cents a quart.
With skim milk at 2 cents a quart.
The dry grain fed to these three lots was Meal No. 5, which cost at current prices a proximately $2.50 a hundred. All costs are figured from prices current in September. 1 4.

Discussion of the Results.

In the first place the results of the several trials, as summarized in the preceding table, confirm our previous knowledge relative to the superior value f growth of skim milk for young calves, providing it can be had at a reasnable price (1.5-2.5 cents a quart). Even at 1.5 cents a quart, the food ct of growing calves to four months of age is considerably above that of t calf meals; but *on the basis of growth produced*, the food cost is about the same as for the several meals. Only, however, when liquid skim milk is not available at such prices should calf meals or skim milk powder be substituted.

In the second place our studies show that calves can be raised on various skim milk substitutes together with a minimum of skim milk, and fairly good growth secured. Care has to be taken not to overfeed. Many of the calves thus grown are apt to look rather rough and not as smooth as skim milk calves. After they have reached the age of 6-8 months this difference generally disappears. The average amount of skim milk consumed by the calves raised on the various meals was 211 quarts, as compared with an average consumption of 1046 quarts by the calves in the check lot which were raised on skim milk and dry grain and hay. Those fed skim milk and starch consumed on an average 912 quarts of skim milk. The calves reared on Meal No. 6 received an average of only 108 quarts of skim milk each.

It must be admitted that the dairyman who raises a few calves at a time if he does not have skim milk available, will have to depend upon the manufacturer for his calf meal mixtures. The manufacturer can secure and blend the different ingredients more cheaply than the small feeder; hence the result of station studies along this line are likely to be passed to the dairy farme through the manufacturer.

The work has shown quite conclusively that skim-milk powder is a promisin substitute. This material is fairly easily obtained, can be readily prepare for feeding, and at present prices costs very little more than liquid skim mill The addition of starch spares the amount of milk powder, but slightly increase the cost of the gain. Because in the processes of drying the skim milk, it i heated to 140° Fahrenheit or above for a considerable time, it would appea that the danger from disease germs is likely to be remote.

Finally it may be remarked that success in calf rearing is dependent not onl on the feed used but on several other factors which are:

(a) A vigorous calf at birth.
(b) Clean pens and clean feeding utensils.
(c) Regular feeding hours.
(d) Special attention to the individual peculiarities of each calf.
(e) Milk or gruel always fed at the same temperature—blood heat or ther abouts.
(f) Care to prevent overfeeding. If the calf refuses part of his allowan let him go hungry at the next meal, or if he starts to scour cut h ration in half for the next twenty-four to thirty-six hours.
(g) Sunshine, fresh air and exercise. Access to pasture if possible aft the calf is six months of age; at least an open yard to run in, exce in severe winter weather.

The above bulletin is a report of progress only. The study of skim-mi powder and of milk substitutes for young calves is being continued alo somewhat different lines and any pronounced progress will be reported.

Practical Suggestions.

On the basis of the work reported in this bulletin, we are not prepared recommend any particular combination of ingredients going to make up a ca meal mixture. Combinations No. 2 (see page 45) and No. 6 (see page 47) ha done fairly well. As already stated, the most promising substitute inves gated has been skim-milk powder and a combination of the powder with co starch.

If skim-milk powder is used as a substitute for liquid skim milk, it is su gested that one pound of the powder and a scant even teaspoonful of salt fed to each gallon of water. The milk powder and salt should first be stirr with a small quantity of cold water to avoid lumping and after a creamy co sistency has been secured the necessary amount of lukewarm water shou be added, the mixture well stirred and thus fed. Do not feed the solution co

If skim-milk powder and starch are fed, mix as follows:

1 lb. of dry skim milk
½ lb. of corn starch
Level teaspoonful of salt.

Five ounces of this mixture should be added to each quart of water. The ethod of mixing consists in adding to the powder a small quantity of cold ater and thoroughly stirring in order to avoid lumping. After a creamy nsistency is secured, add the necessary water, stir and heat the mixture to 0° Fahrenheit and allow it to cool to blood heat before feeding. An amount fficient for one or two days can be mixed at one time, but before feeding, it ould be well stirred and heated until it is lukewarm.

COMPOSITION OF CALF MEALS

Material	Water	Dry Matter Basis*				
		Ash	Protein	Fiber	Nitrogen-free Extract	Fat
lf Meal No. 1	9.92	4.27	32.24	2.61	56.62	4.28
lf Meal No. 2	8.93	4.75	18.12	2.51	70.10	4.52
lf Meal No. 3	8.56	4.98	21.87	2.68	67.00	3.46
lf Meal No. 3, modified	9.76	4.67	22.40	2.42	65.98	4.52
lf Meal No. 4	6.49	4.68	27.35	3.84	59.40	4.73
lf Meal No. 5	10.18	4.40	21.02	6.71	61.07	6.79
lf Meal No. 6	10.71	5.22	24.64	3.54	61.88	4.72
m-milk powder and starch gruel	88.90	8.05	20.72	none	71.26	trace
m milk and starch gruel	88.70	6.99	18.58	none	74.42	trace

*In case of the dry meals to reduce roughly to normal water basis, deduct 10 per cent. l for the skim milk and starch gruels, deduct 90 per cent.

A study of the chemical composition of the several meals shows that they ntain, when ready to feed, about 10 per cent of moisture, 4-5 per cent of neral matter, 2-3 per cent of fiber, 60-70 per cent of extract matter (largely rch), and 4-6 per cent of fat. The protein percentage in the several meals ries widely—from 18 per cent in case of Meal No. 2 to 32 per cent in case No. 1. We have no positive knowledge as to the best percentage of this gredient, but on the basis of our experience believe that 18-24 per cent should ove satisfactory. The fiber percentage should be kept as low as possible, pecially in a meal that is to be used in the gruel form during the first few nths of the life of the calf. A reasonable amount of fat is desirable. It doubtful if 5 to 7 per cent is at all excessive.

6000. 4-7-'25. Order No. 1473.

MASSACHUSETTS

AGRICULTURAL EXPERIMENT STATION

Bulletin No. 224 March, 1925

THE COSTS OF MARKETING THE APPLE CROP OF 1923

By Lorian P. Jefferson

Knowledge of costs is a necessary antecedent to control over them. Increasing competition from other producing regions makes it necessary that Massachusetts orchardists know their costs, and be prepared to reduce them, to give better marketing service, in order to maintain the strategic position which is and should continue to be theirs. The study which this bulletin reports was initiated, therefore, as an attempt to determine the factors of cost which Massachusetts orchardists must meet in getting their product from the orchard to the market which they serve.

Requests for bulletins should be addressed to the

AGRICULTURAL EXPERIMENT STATION,

AMHERST, MASS.

4-24-'25. Order No. 1620.

THE COSTS OF MARKETING THE APPLE CROP OF 1923

By Lorian P. Jefferson

This study was undertaken in order to determine the costs of putting ap on the market, what grades may be marketed with profit, the margin over co of marketing returned to the grower from sales by various methods, and type of container most desirable.

Information was collected by personal visits to growers, 65 individual rep being obtained beside that from the Nashoba packing house.

No attempt was made to secure data from all growers in any section, those growers visited were representative. Data were obtained in four s tions of the state—Franklin County; Granville, a small and comparativ new area near the Connecticut line in Berkshire County; the Newbury sect in the northeastern corner of the state; and an extensive area centering ab Littleton, but including many widely scattered growers of Middlesex and W cester Counties.

The data used were sometimes taken from records, bills of sale, etc., k by the grower, and sometimes—more often indeed—they were thoughtful e mates of the producer. Most of those visited gave such estimates for at le a part of the information sought, although many had some sort of record which the figures were based. These figures were carefully tabulated, omitt the few questionable returns.

It was found that, owing to wide ranges in the reports, averages were always representative of the expenditures for various items. In these ca the most common cost was used as typical. Hence the tabulation summariz the costs must be considered merely as a fairly representative list of co All averages are weighted except when otherwise stated.

No attempt was made to discover the cost of growing the fruit. It m therefore be recognized that the "margins" or "returns" considered through the study are to be regarded as profits only after the costs of growing deducted from the "margin over cost of marketing."

One grower said that apples could not be sold at a profit unless the pr obtained was more than $3.50 a barrel. Another said that it cost $2.00 grow and market a bushel of apples. Obviously a wide range exists in individual costs of production as well as in the costs of marketing. A d ference of 83 cents a bushel appears between the two cases cited.

Grades.

The law of the state provides for three grades of apples—Fancy, A and —and an ungraded class. In reality, the apples known as ungraded are two kinds: those which are sold as they come from the trees, culls only havi been removed; and the inferior grade which remains after Fancy, A and grades—any or all of them—are taken out. The term "ungraded" as appl to this inferior lot of apples is a misnomer, and some other designation shou be devised.

The growers visited reported 214,153 bushels of apples sold from the cr of 1923. Seventy-five per cent of these were sorted and graded. The grad appeared in the following proportions:

Grade	*Bushels*	*Per Cent*
Fancy	17,640	8.1
A	68,816	32.1
B	29,273	13.7
Ungraded	90,062	42.0
True	52,007	24.3
Inferior	38,055	17.7
Cider	8,362	3.8

)f the apples which were graded, 13 per cent were Fancy; 51 per cent were ; 22 per cent were B's; while 14 per cent were the inferior stock, called ıgraded," left after the higher grades were sorted out. Some few of the wers graded into all grades, but most of them did not. Sixteen per cent ort apples of the Fancy grade; 41 per cent sold apples of A grade; 27 cent sold B grade; and 17 per cent sold ungraded stock which remained er the higher grades had been sorted out.

thods of Sale.

Probably the most important single factor in determining the price received apples is the method of sale. Obviously, whether the highest price means the greatest profits depends upon costs of production and costs of maring.

Several methods of sale were found in current use among the growers visl:

. To the buyer, who comes to the orchard or packing shed, usually proes his own containers, and may be a huckster, a jobber or a wholesaler. s method is common throughout the state.

. To the wholesaler, to whom the apples are usually delivered by the wer.

. On commission, the rate of commission varying from 7 per cent of the ing price for apples which are exported, to 12 per cent which is the comı rate on the Worcester market.

. To the retailer, the grower generally paying the delivery charges, alugh in at least one instance the retailer buys the entire crop of the grower hauls it away on his own trucks, a distance of 30 miles.

. Cooperatively, there being one cooperative packing association and one perative roadside market selling apples.

. At retail, at the door or at a roadside market maintained by the grower.

. From door to door, probably the most expensive method of sale.

. At a farmers' market. One grower only reports sales by this method his fruit is sold chiefly to retailers and hucksters.

ale to buyers who come to the door is probably the most common way of ing throughout the state, 55 per cent of the growers visited selling all or t of their crop to buyers at the door. Some of the buyers are hucksters sell in various cities throughout the state. Some are wholesalers and some are retailers. Frequently the fruit is bought "orchard run" at the farm the grower has no responsibility for it after it is picked and hauled from orchard. Most of these buyers seem to make the best bargain possible ı each individual grower, having neither fixed price nor fixed terms of chase, and these terms may differ widely in any community. Particularly his true in the western part of the state. One grower sells his apples on trees, the buyer picking, sorting and packing them and hauling them to station. Another grower picks his apples, hauls them to the packing shed, plies one packer, while the buyer supplies one or two. Sometimes the wer furnishes two or three packers and boards another who is hired by buyer. The grower may or may not deliver the apples f.o.b. his loading ion.

he same variations appear in the prices paid by these buyers, who somes request the growers not to reveal the price paid. The range of prices the different grades of the crop of 1923 varied as follows:

A	$3.00 to $5.00, per bbl.	with eight different prices.
B	$2.75 to $3.60, per bbl.	with five different prices.
Ungraded	$1.00 to $4.00, per bbl.	with twelve different prices.

ore than half the apples reported for this study by Franklin County vers are sold absolutely ungraded; while but 6 per cent are sold as the rior lot, misnamed "ungraded," remaining after the better grades are ed out.

Vith the exception of those who sold their apples on the tree, the growers sold to these buyers always paid two items in the cost of marketing— ing and hauling from the orchard to the packing shed. From this point, varying bargains were made by the buyers. They did all or any part, co monly one-half, of the sorting, grading and packing; they furnished the c tainer in some cases, while in others it was furnished by the grower; eit the buyer or the grower hauled to the station, as was agreed. The frei was generally paid by the buyer.

The reasons for this undesirable situation seem to be:

1. The distance from market. Most of the orchards lie at a considera distance from the large markets in the western part of the state, and small markets are soon over-stocked. The haul to Holyoke or Springfield long—40 miles at the least, and for some of the growers it is 50 miles or mo On account of the hills this haul is more difficult than one of the same mile in a more level section. It is more convenient and less expensive to sell a buyer at the door, or at least at the nearest shipping point.

2. Custom undoubtedly has some influence in the matter. For years th buyers have come to Franklin County for the apples they handle, and growers have formed the habit of selling by this method.

3. The size of the individual crop probably influences to some extent method of sale. The average crop in Franklin County is about 2200 bush and 45 per cent of the growers reporting sell yearly less than 1700 bush each. The average crop in the eastern section of the state is nearly twice large as that in the Franklin County area.

In Worcester and Middlesex Counties the methods of sale are various, l chiefly apples are sold to buyers at the farm, cooperatively, to retailers, a on commission. The most interesting method is the cooperative sale by Nashoba Apple Packing Association, which maintains two packing hous one in Littleton and one in Bolton.

The apples were picked and hauled from the orchard by the grower. Th were hauled to the packing house by the Association at a flat rate of 5 ce a bushel, regardless of distance. Sorting, grading and packing costs w reported as 30 cents a bushel, but this included some items which should ha been charged to supplies. The actual cost of the labor of sorting, gradi and packing was possibly not more than 25 cents a bushel.

The packed box was then hauled to Boston for 12 cents and delivered one commission merchant who handled the entire output of the Association.

There was a very small charge for labels and advertising. With comm sions the total costs of the Association amounted to an average of $1.08 p box.

Over half, 51 per cent, of the growers report that they sell by one meth only; 27 per cent sell by two methods; 18 per cent use three methods, whi four, five and six methods are used by one grower each.

Two growers sell their crops on the tree and have no further responsibilit

Buyers who come to the orchard purchase the entire crop of 30 growe reporting. Nine growers sell to wholesalers, 20 on commission, 23 to retaile 7 to hucksters, 7 cooperatively, 9 at retail at the door or at roadside stand 6 sell from door to door, and one at public market.

Total Costs.

The items of cost which appear in the marketing of apples may be liste as follows, but it is obvious that very few growers would incur each of the expenditures:

- Picking
- Sorting
- Grading
- Packing
- Container
  - Boxes, with risers
  - Barrels
  - Baskets
- Cooperage

Heading of barrels
Nailing of boxes
Paper
Hauling container to orchard
Hauling container to packing shed
Hauling from farm to market
Hauling from farm to station
Hauling to storage
Hauling from storage
Freight
Storage
Selling

It will be noted that the costs of marketing are here considered as beginning th the cost of picking and including all actual expenditures till the fruit in the hands of the first purchaser, whether he be buyer, wholesaler, re- ler or consumer. These costs vary greatly with different growers and to certain extent with the locality.

cking.

The most common cost of picking a bushel of apples, as reported by the oducers visited, was about 8 cents in 1923. The range of costs for this eration was from 3 cents to 20 cents. Of the 62 reporting, 31 paid less in 10 cents a bushel for picking, 14 paid from 10 to 14 cents, and 17 paid om 15 to 20 cents. The average cost was between 10 and 11 cents a bushel.

rting.

Sorting, grading and packing costs vary even more widely than the picking sts, the range being from 3 cents to 42 cents a bushel. The average cost s 13 cents; 43 per cent of the growers report this charge as less than 10 its, 31 per cent paid between 10 and 14 cents, 11 per cent paid between 15 d 20 cents, while 13 per cent report that it cost more than 20 cents a bushel. e most common cost was 8 1/3 cents.

It must be recognized that these figures include all types of sorting, grading l packing; those that are merely put into the container as well as those it are sorted, graded, wrapped and packed, the utmost attention being given each detail. Obviously there must be wide differences between costs. Four- n per cent of the apples sold (ungraded) were reported as having cost an rage of 5 cents a bushel for such sorting and packing as was done. This 37 cents less than the highest charge reported.

rage.

Comparatively few growers stored apples and only 15 of these were able give costs of storage. The range of this charge was from 3 cents to 32 ts a bushel, but includes farm storage as well as hired cold storage, the m storage being estimated on the basis of interest on the cost of the storage. e average cost of storage per bushel of apples stored was 23 cents. This rage is much increased by the costs of a few growers, as one-third of those orting storage costs paid less than 10 cents a bushel.

ntainers.

More than half the costs of marketing apples in Massachusetts may often charged to the container. The average price of barrels to 45 growers, who in this way, amounts to 23 cents per bushel sold. The prices reported ged as high as 85 cents a barrel including cooperage and delivery. Some wers buy second-hand barrels when these are obtainable, and some report t the barrels are returned by the retailer or the consumer.

Boxes cost an average of 21 2/3 cents as reported by 30 growers, and the st common price is 22 cents. Baskets are reported in several sizes, holding

2 quarts, 4 quarts, 8 quarts, 14 quarts. 28 quarts, a half-bushel and a bush The cost of baskets averages, for the 23 growers who report their use, abo 26 cents a bushel.

The one grower who reported sales in 2-quart baskets paid at the rate 48 cents a bushel for these containers. Four-quart baskets cost an avera of 32½ cents a bushel. Selling in baskets containing 14 quarts meant average expenditure of 23 cents a bushel for containers, while baskets holdi 28 quarts cost an average of 17 cents a bushel. Baskets containing a bush cost an average of 13 cents.

One instance was found where the containers, "barrel crates," were t property of the buyer, who charged the grower 25 cents each for their us The grower had, however, provided storage space for these crates betwe seasons, and for this service the buyer allowed him 12½ cents per crate. Th amounted to nearly 3 cents a bushel cash outlay for containers.

The type of container most desirable seems to depend upon the gradi done. Ungraded apples are probably more suitably packed in barrels, whi graded fruit may better be packed in boxes. Baskets seem to be used f retail trade particularly.

Selling Costs.

The cost of selling varies greatly with the method of sale. The most e pensive methods being, apparently, from door to door and at roadside ma kets, but accurate data as to these methods are very difficult to obtain. Qua tities thus sold vary from day to day with a consequent change in selli costs per unit.

Selling on commission is most commonly at a rate of 10 per cent of t selling price, although exported apples are sold for 7 per cent commissio and rates here run as high as 15 per cent. Sales in Worcester are report at 12½ per cent. The average cost of selling on commission was 19 cen a bushel.

The selling costs of 106 lots of apples sold varied from 4 cents to 90 cen a bushel. The most common cost was 10 cents a bushel, 11 per cent of t lots reported showing this selling cost. The average cost of all these lo was 18 cents a bushel.

There were in addition 36 lots, most often the entire crop, sold to buye who came to the door, relieving the grower of all selling costs except for t time required to bargain with the buyer. For the purpose of this stud there is no cost of selling included for the lots of apples so sold.

The average selling costs on all lots reported, 142 in number, was near 14 cents a bushel, but this figure has little significance in view of the wi variation in individual costs. The weighted average selling cost was 18.6 cen per bushel.

Transportation.

The cost of hauling from orchard to packing shed is most commonly abo 2 cents a bushel, 34 per cent of the growers reporting this cost, while 77 p cent report a charge of less than 5 cents a bushel for this item. The highe cost reported is 12½ cents a bushel.

More of the crop is hauled to market by truck and wagon than is shipp by freight. The cost of hauling to market ranges from 3 cents to 33 1/3 cent The most common cost is 15 cents: 42 per cent of the growers report th cost to be either 15 or 16 cents, while 30 per cent haul their apples to mark for less than 15 cents a bushel.

The most common cost of delivery at the station is 5 cents a bushel, t range being from 5 to 11 cents.

Two-thirds of the growers use motor trucks, mostly privately owned, b a few are hired. The average length of haul by truck is 20 miles, practicall always to market, though a few haul by truck to their railroad stations, d livery being thence made by freight. Wagons are used by the remainder the growers, and three report that they use both, depending upon the weathe The average wagon haul is 4 miles and the haul is commonly to the statio few, however, report that apples are hauled by wagon to nearby markets. gons are used almost entirely in the western part of the state where the s sometimes render hauling by truck a difficult matter.

he average haul for all vehicles is about $15\frac{1}{2}$ miles, while the most common l is less than 10 miles. The average haul by wagon is about 4 miles at average cost of \$.0169 for hauling one bushel one mile. The average haul truck is 20 miles, at an average cost of \$.0092 a mile for each bushel led.

he mileage cost per bushel hauled by truck less than 10 miles is \$.0136, rly $\frac{1}{4}$ cent less than by wagon.

or distances varying from 10 to 24 miles, the trucking cost per bushel rages \$.009 per mile, while for distances of 25 to 43 miles (the greatest orted) the average cost is \$.0053 per bushel per mile.

he most common cost for trucks lies between $\frac{1}{2}$ cent and 1 cent per mile a bushel, while the most common cost for wagons lies between 1 cent and cents. One-fifth of the trucks carry a bushel a mile for less than $\frac{1}{2}$ cent, e $8\frac{1}{2}$ per cent report cost exceeding $1\frac{1}{2}$ cents a mile for each bushel led. The highest cost reported was slightly more than $5\frac{1}{2}$ cents, which ears in both truck and wagon costs. The lowest cost was reported for a k hauling a distance of 30 miles for 15 cents a barrel, \$.0016 a bushel mile. The most common length of haul by truck was 30 miles at an age cost of \$.0058 per bushel per mile. The average cost for all vehicles ractically one cent a mile for each bushel handled.

ransportation costs for trucks amounting to nearly the same figure are rted from the eastern and western parts of the state. Few wagons are in the eastern section, except for hauling from the orchard to the pack- shed.

r Apples.

der apples included culls and apples from wild trees unfit for other use. se were sold mainly at local cider mills, although some few growers make sell their own cider. Cider apples brought an average price of about 17 s a bushel, but they are sold mostly by the hundredweight.

es and Margins.

ollowing is a comparison of the prices and margins over costs of mar- ng received for the various grades by different methods of sale. The three ods most commonly employed among the growers visited are here pre- d, since the great part of the apples reported were sold by these methods. is notable that in every case sales to country buyers showed the lowest s and lowest margins over costs of marketing. Sales of Fancy apples etailers brought the highest margins over costs of marketing. Sales of on commission brought the highest price for this grade, and sales on com- on averaged the highest prices and the highest margins.

e true ungraded apples brought the highest prices for this grade when on commission, but a small quantity of inferior ungraded sold to a re- r brought the highest margin over costs for this grade. This was due to fact that the retailer supplied the container and hauled the apples from arm, making the actual expenditures of the grower very small. However, price received was not as high as for those of the same grade sold on nission. Ungraded apples returned lower prices and margins over costs arketing by all methods of sale than did graded fruit.

e influence of low grades of a product upon the prices received for the r grades is difficult to calculate, but it is the opinion of many growers dealers that the low grade apples might be kept off the market with profit e grower. It is doubtful, for example, if the margins over the costs of eting ungraded apples, when sold to country buyers particularly, cover of production. In 1923 it is certain that some growers lost on B grade es, and others made little or nothing by selling this grade. Some few ers made their low grade apples into cider which was sold at a roadside et.

Average Prices, Costs of Marketing, and Margins over Costs of Market

	Bushels	*Average Price*	*Cost of Marketing*	*Margin over Co of Marke*
		FANCY		
To country buyer	1,224	$1.67	$ .53	$1.14
To retailer	180	2.12	.38	1.74
Commission	9,636	2.07	.45	1.62
		A GRADE		
To country buyer	14,697	1.23	.49	.74
To retailer	13,824	1.93	.81	1.12
Commission	18,495	2.20	.98	1.22
		B GRADE		
To country buyer	3,594	1.34	.60	.74
To retailer	5,280	1.51	.63	.88
Commission	9,201	1.56	.88	.68
		UNGRADED—INFERIOR		
To country buyer	12,535	.91	.41	.48
To retailer	225	1.08	.10*	.98
Commission	19,414	1.90	1.06	.84
		UNGRADED—TRUE		
To country buyer	27,980	.88	.39	.49
To retailer	8,300	1.10	.40	.70
Commission	2,000	1.92	.84	1.08

*Sold at door, buyer furnishing container and hauling away.

A comparison of the prices and margins over costs of marketing for graded apples and for those ungraded which are merely picked, sorted packed is of interest. All graded apples, including the so-called ungra remaining after other grades are removed, brought an average price of $1 per bushel, with an average margin of $1.03. The true ungraded ap brought an average price of $1.03 with a margin over costs of marketing 57 cents a bushel, practically half the margin on all graded apples. Omitt the inferior grade, the graded apples brought an average price of $1.88 w an average margin of $1.08 per bushel.

According to the data tabulated, B grade apples sold to country buy brought a higher average price than did A's sold by the same method. T may be explained by the fact that comparatively few apples of B grade w sold by this method, tending to give undue weight to any unusual instanc and that some lots of apples brought the same price for A and B grades.

In the case of ungraded apples, it is noticeable that the country buyer p more for the inferior class than for the true ungraded. This may, perha be explained by the probability that the growers who grade their apples ca fully do so because they are better acquainted with market conditions a are therefore in a position to make a better bargain with the buyer.

Information secured with reference to the expenditure of labor necess to pick, sort, grade and pack showed that there is a wide variation in la as in money costs. The average number of bushels reported picked in a d is about 48, although orchard conditions have a marked influence in the matt Sorting, grading and packing, which are usually considered as one item, erage a little higher, one worker packing about 54 bushels a day. Many gro ers, however, estimated that the labor costs of this item are about the same for picking.

[I]t is almost impossible to give the cost in labor of other items, such as h[au]ling and storing, because the work is done so intermittently that the amount o[f] time required per bushel or the amount of work done in a day is difficult t[o] estimate.

A tabulation of the average or most common expenditures for the various it[e]ms entering into the costs of marketing will serve as a summary.

Operations	*Cost per Bushel*
Picking	$ .10
Sorting, grading and packing	.13
Container	.23
Hauling from orchard	.02
Hauling to station	.05
Hauling to market	.15
Selling	.19
Typical costs of marketing apples hauled to market	$ .87
Storage	.23
Hauling from storage	.05
Typical costs	$1.15

The study leads to certain definite conclusions.

1. Sale to country buyers is the least profitable method of sale.
2. It pays the grower to grade his apples. How closely this may profitably be done depends, obviously, upon the character of the crop.
3. Sales on commission returned, to the growers reporting, the highest average prices and the highest average margins over costs of marketing. These sales were made in some cases throughout the season, thereby taking advantage of the season of highest prices. The 10,000 bushels sold cooperatively were in this group. Some other methods, *e.g.,* sale to country buyer, dispose of the crop early in the season, when prices are likely to be low.

MASSACHUSETTS

AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 225 DECEMBER, 1925

YELLOW PICKLE IN GREENHOUSE CUCUMBERS

By VICTOR A. TIEDJENS

Contribution from the

MARKET GARDEN FIELD STATION

of the

MASSACHUSETTS AGRICULTURAL COLLEGE

Yellow pickles on greenhouse cucumber plants are due to a physiological isorder causing the fertilized pickles to ripen prematurely. Any environ-nental factor that reduces the amount of food material in the plant may esult in a condition favorable to the formation of yellow pickles. In-dequate light, insufficient nitrates, excessive set, surplus water, poor rainage, or a serious attack of animal or plant parasites may all con-ribute to a premature ripening of cucumbers. The remedy is primarily he prevention, elimination, or correction of those conditions that tend to evitalize the plant.

Requests for Bulletins should be addressed to the

AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

YELLOW PICKLE IN GREENHOUSE CUCUMBERS

By VICTOR A. TIEDJENS

Perhaps no other problem causes greenhouse cucumber growers more concern than the appearance of a large number of yellow pickles when the vines should be yielding at their maximum. Whenever plants are weakened from disease, poor growing conditions, or a heavy set, yellow pickle[1] is always present. Some growers attribute it to degenerated seed, some regard it as mosaic, while others ascribe the condition to lack of pollination by bees. Observations on self and cross-fertilized cucumbers for two generations lead to the conclusion that these assumptions are to a certain extent correct, but the condition is due to many more causes than any one group is usually willing to admit.

Yellow pickles may be the result of one or more causes such as too heavy a set, poor pollination, the method of growing (whether string or A trellis is used), insufficient soil nutrients, animal or plant parasites, or conditions that weaken growth and stunt the plant.

The Condition Called Yellow Pickle

Reference is made to yellow pickle as a condition because it is usually secondary and is brought on by one or more causes. As a rule yellow pickle manifests itself on small cucumbers on old diseased vines, or heavily set vines which are in the first set. Occasionally the condition is found in cucumbers from six to eight inches long if the plant has experienced a sudden shock or "set back." Ordinarily, in the condition known as yellow pickle, the cucumber does not grow beyond a length of four inches. After growth is stopped the cucumber becomes yellow near the stem end, the yellow color gradually spreading toward the tip if decay does not set in first. Some make sufficient growth to mature a few viable seeds. If sufficient growth has not been made to develop viable seed, the cucumber wilts and gradually dries up.

If it has been fertilized, the yellow pickle may remain on the vine from four to six weeks before it drops off. This condition has been called premature ripening, but differs from that of a normally maturing cucumber in that the yellowing of the mature cucumber becomes visible over the entire surface, the stem end being less pronounced in color than the remainder of the cucumber, a condition directly opposite to that found in yellow pickle. Plants may have from one to six or more of these yellow pickles at one time, depending on the set of the plant. A plant having a heavy set may develop only half of the pistillate flowers into marketable cucumbers, in which case the other half becomes yellow, the proportion of yellow pickles to normal cucumbers depending on the vigor of the plant. A weak plant may mature only one of many pickles fertilized, in which case the percentage of yellow pickle will be very high; whereas, although a strong plant under the best growing conditions may not mature all its pickles if the set has been exceptionally large, the percentage of yellow pickle will be relatively small.

1. There is some confusion in the use of the two terms ''yellow'' and ''white'' pickle. The condition here referred to as yellow pickle may result from any one of several physiological causes and manifest itself in a premature yellowing of the pickle.

The Relation of Fruit Set to the Development of Yellow Pickle

A cucumber plant grows in cycles with reference to producing pistillate flowers. After a large number of pistillate flowers have been produced, that is, one on each node up to the first ten nodes of the stem, only staminate flowers are produced for a number of new nodes higher up, followed by another group of pistillate flowers. Thus a "set" usually follows the removal of a number of large cucumbers from the vine. Usually more pistillate flowers are produced in one set than the plant will mature, and some of them must be sacrificed. Under greenhouse conditions, where all the flowers are in a favorable position to be visited by bees, a very large percentage of the female flowers set fruit. If conditions are ideal for good growth, the plant may be able to mature a complete set. Usually, however, a few of the cucumbers formed on the first few nodes of the plant are a day or two ahead of the others and develop normally, while the later pollinated pistillate flowers make very little growth until the first formed cucumbers have been picked. If growing conditions are unfavorable so that several weeks are required to grow the market size cucumber, the pickle becomes stunted and, even though conditions later become favorable, it does not grow. Instead a newly pollinated flower may start and as a result the small pickle is prematurely ripened. It may have a few viable seeds or it may not have grown sufficiently to develop any seed. The pickle turns yellow, a condition which many growers have attributed to a parasitic disease. An infection of a plant by an organism is probably the most important cause of yellow pickle on normal plants.

The condition cited above very definitely manifested itself in self-pollinating work on old plants which had set a number of fruits. A study was undertaken of certain characters existing in a mixed lot of cucumbers grown in the station greenhouse. Self-pollinated flowers, on plants already having a number of pickles set, invariably developed yellow pickle; and not until every pollinated flower and developing cucumber were removed from the plant was it possible to get the plant to produce any self-fertilized fruit. On the other hand, when the first flowers of the plant were self-pollinated the fruit developed and matured, indicating that self-pollination was not the determining factor.

Yellow pickle was very much in evidence on plants used for seed production in breeding work. As many as eight pistillate flowers on a plant were selfed, but only three or four matured while the others remained for several weeks without growing, and then turned yellow. It was not uncommon to find five or six yellow pickles on these plants because of the time required to mature the early pollinated fruit.

Since, in the production of seed, the mature cucumber must remain on the vine much longer than that which is picked for market, much more food material is required and the plant is not able to carry as much maturing fruit as if all were picked green. Under such conditions yellow pickle is very much in evidence.

Generally yellow pickle is associated with old vines, but the plants in the above experiment were in their first set. This brought out the fact that yellow pickle is a premature ripening of pollinated flowers at a time when the plant is carrying a heavy load. The second set came along after the mature seed cucumbers were removed. The fruits from this set produced good marketable cucumbers while the yellow pickles were still hanging on the vines. A few that had not turned yellow failed to grow after standing still for such a long time, and finally dried up without becoming yellow. The flowers from which these yellow pickles developed were self-pollinated on June 21, 1925. The pickles did not begin to turn yellow until August 8, 1925, 48 days later. Some of them were three to four inches long and a few had some viable seeds.

Relation of Pollination to the Development of Yellow Pickle

Many cases of yellow pickle can be attributed to lack of pollination. However, with certain varieties, when a pistillate flower is not pollinated, its growing period is much shorter, and the pickle very seldom grows over two inches. Often it does not have the characteristic yellow color found on the larger pickles. In the case of the English variety it is possible to mature large cucumbers without pollination, but this is not the case in the ordinary varieties used in a study of this problem. Yellow pickles were found, however, on English vines which already had three or four mature cucumbers.

Interest in the yellow pickle problem prompted the bagging of a large number of pistillate flowers to prevent visitation by insects. None of these flowers developed pickles over two inches long. The color was a grayish yellow and in some cases almost white. Some of these decayed in a short time, while others dried up and dropped off, a condition differing from that described above.

The Relation of Method of Growing to Yellow Pickle

Two methods of growing cucumbers in greenhouses are generally practiced; namely, the "A" trellis method, and the string method. Where the "A" trellis is used, fewer plants are necessary and these develop more normally than with the string method. With the string method the plants are closer together, and are pruned so that each branch has only one or two nodes, the main stem being twined around the string which extends from a wire near the top of the house to the base of each plant. The prevalence of yellow pickle depends somewhat on the method that is used.

The number of pistillate flowers formed is largely determined by hereditary factors. Thus, there will be as many pistillate flowers on the main stem and first two nodes of the branches whether the plants are grown on strings or trellises. In the string method, a large amount of leaf surface is removed in pruning, thus curtailing the amount of food the plant can manufacture and store. Such plants cannot develop as many of the pistillate flowers as those on the "A" trellis where very little pruning is done. Also, the plants are crowded more in the string method and less soil nutrients are available to each plant. This means that there are likely to be more yellow pickles on the string plants under uniform conditions of growth. This has been commonly observed, but not proved by tests under controlled conditions.

Relation of Parasitic Diseases to Yellow Pickle

As was stated in the introduction, yellow or white pickle resembles symptoms of mosaic. It is also common to find yellow pickles associated with diseases produced by animal or plant parasites, but the yellow pickle with which we are here concerned does not come within the category of any of these diseases. When plants are affected with disease their health is impaired to the extent that they cannot mature their fruit and grow new foliage as normally growing plants can and consequently the fruit is prematurely ripened. As cucumber plants grow older, especially with the string method, they shade each other more, and for that reason the lower leaves either drop off naturally or succumb to disease. Under such conditions the plants are unable to carry to maturity the fruit which was polllinated when they were in a fairly healthy condition, and consequently many yellow pickles appear.

Soil Conditions and Yellow Pickle

Ordinarily the soil in a greenhouse is so well manured that if it is handled properly there will be sufficient soil nutrients present to carry a crop of cucumbers from nine months to a year, or as long as the vines are able to produce a paying crop. There are, however, certain conditions caused by poor drainage which tend to shorten the growing period of a plant, and materially cut down the yield. After cucumbers are transplanted, a period of soil saturation with water follows so that the plants are continually growing in a wet soil, which is usually too wet for healthy growth. If good drainage is provided, as in benches, little damage will result. If no drainage is provided, the soil becomes water-logged, oxygen is excluded and practically no nitrification takes place. The plant does not receive sufficient nitrates to make a healthy growth and a large number of yellow pickles results. Even if compost manure or fertilizer is applied on the top of the ground and kept moist, the plant will not function properly as long as the soil is in a water-logged condition. This undoubtedly has much to do with the longer growing period of cucumbers when grown in benches.

The cucumber plant needs a large quantity of water, but it will not thrive if the roots do not receive sufficient air in the presence of too much water in the soil. Greenhouse growers claim that plants wilt if the soil is not thoroughly wet down. This is true, but they will wilt even though more than the necessary amount of water is added, the reason being that the plants have received so much water from the time they were set in the beds that the root system is not large enough to balance the upper part of the plant. The roots remain near the surface and will not branch out and down for water and food. They are near the surface where there is air. It is the same condition found in a poorly drained field. If plants wilt during hot dry weather, growth is interrupted to the extent that many cucumbers become stunted and produce either nubbins or yellow pickles. Proper watering after transplanting will prevent much of this trouble. An excess of water from the time the seed germinates makes a soft plant which requires a large amount of water. It is impossible to give such a plant sufficient water during hot dry weather to prevent it from wilting, because the root system is not large enough to replace the water that is given off by the leaves. Undoubtedly, cucumbers grown with less water from the start are more lignified (less soft), have stiffer cell walls, and do not droop so readily even when there is a slight water deficit.

This condition of the soil has considerable influence on the health of the plant. The number of yellow pickles will be influenced by the condition of the plant.

The Relation of Deformed Cucumbers to Conditions Causing Yellow Pickle

The cause of nubbins and deformed cucumbers is usually attributed to the fact that the flower was improperly fertilized or that the seed is degenerating. Both answers seem improbable in the light of certain observations on both healthy and diseased plants. There are plants so genetically constituted that they produce only nubbins or deformed cucumbers. But many plants later in life produce nubbins and deformed cucumbers which earlier produced number one cucumbers only. In this case we cannot attribute the condition to heredity. When nubbins are produced on greenhouse grown cucumber plants that are as freely visited by bees as plants producing number one cucumbers, we hesitate to attribute the result to a lack of pollination. It would be supposed that hand pollination should overcome the trouble, but experience has shown that resorting to such a method is no assurance that the cucumbers will be normally formed. Therefore we are led to think that the physiological balance of the plant is upset to the extent that fertilization is abnormal. This assumption, however, cannot be proven at the present time. When a plant is weak and an insufficient supply of food is available to nourish the newly pollinated flowers, the time when any given flower is pollinated may have some influence on the shape of the fruit developing from it. The number of growing cucumbers on a plant is undoubtedly a contributing cause of the production of nubbins and deformed cucumbers. By observation it has been noted that the condition of the fruit indicates the conditions under which it was produced. That is to say, if a plant is in good health and sets six cucumbers on six succeeding days, they may all start to grow. If something tends to cut down the food supply, four of the cucumbers, depending on time of pollination and position on the plant, may continue to grow uninterruptedly, while the other two stop growing until more food material is available. If two of the four cucumbers are picked the remaining two may resume growth. However, the plant is producing new foliage and new flower buds while cucumbers are maturing. If no new pistillate flowers have been formed, the two small cucumbers may grow and form cucumbers, the upper half of which will be small, while the tip half will be quite bulgy and will contain a large number of viable seeds.[1] However, if new pistillate flowers have been pollinated on the plant, they may receive the support of the plant and grow while the two small cucumbers either ripen into nubbins with a few viable seeds or become yellow pickles. This condition applies only to plants which under normal conditions produce cucumbers of good shape.

The Application to Practice

Growers ask as to what can be done to avoid yellow pickle. The better control is, obviously, prevention. When all the yellow pickles and mature cucumbers are removed the plants put forth new growth and develop pistillate flowers, providing abundant supply of required nutrients and foods manufactured by the leaves is available. If the plants are kept healthy and vigorous at all times they will carry more pistillate flowers to maturity. Growth must be continuous and rapid. The presence of a number of

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1 The seeds from a number of self-fertilized cucumbers of this shape have produced plants which bore perfect normally shaped cucumbers.

maturing fruits suppresses many of the newly pollinated pistillate flowers and causes their fruit to become yellow when there are insufficient nutrients or food materials to allow rapid development of fruits present. Uniform night temperatures with moderate watering and an occasional light application of a nitrogen fertilizer to keep the plants growing, reduces yellow pickle to a minimum.

All cucumber houses should be well drained to prevent the soil from becoming water-logged. The young plants should be lightly watered to make them send out a good root system. The soil should be watered in such a way that the water will not stand on top of the ground. A sprinkler system is better than a hose without a nozzle, because not so much water is applied and it soaks into the soil better. The plants should be watered when it is necessary. They should not be watered as a matter of daily routine. The objective should be to get a good vigorous, healthy, fast-growing plant that will mature a large number of fertilized flowers.

Nubbins and deformed cucumbers should be removed from the vine as soon as it is apparent that they will not be well shaped cucumbers, since if once deformed they can never develop into a salable form. If they are left on the vine in the hope that they will develop into good cucumbers, they merely drain the strength of the plant and prevent it from developing normal fruit. Much less vitality is needed to produce a normal cucumber of salable size than is used to carry a nubbin to maturity, since in the former the seeds are small and undeveloped while in the latter the fruit ripens and seeds are fully developed. The removal of a maturing cucumber results in further production of pistillate flowers, and consequently further fruit production. It is a slight task to remove the nubbins when the vines are being trained or pruned.

Pruning should be a daily rather than a monthly practice. Much less damage is done if the growing tips of branches are pinched off than if seven or eight nodes are allowed to form on the branches and are then cut off with a knife. A large amount of sugar is made by the leaves of these branches and if they are cut off suddenly a starvation effect is brought about, the physiological balance of the plant is upset, and a large number of nubbins or yellow pickles will be produced.

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Massachusetts
Agricultural Experiment Station

BULLETIN No. 226 JANUARY, 1926

RESEARCH SERVICE

TO THE

MASSACHUSETTS APPLE INDUSTRY

PROGRESS REPORTS

This bulletin contains ten papers summarizing the more practical aspects of some of the experimental work of the Station that is of interest to fruit growers. More complete reports of some of this work may appear later in separate publications. The subjects reported upon are as follows:

Requests for Bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION,
AMHERST, MASS.

THE APPLE SITUATION

BY LORIAN P. JEFFERSON AND HUBERT W. YOUNT

During the summer of 1925 a study of the Massachusetts apple industry was conducted as a part of an all New England study under the auspices of the agricultural experiment stations. The purposes were to discover the numbers and varieties of non-bearing and bearing trees by ages; to learn certain facts with regard to orchards and orchard practice; to determine the quantities and grades sold of each variety, and the methods of sale and the prices received.

The data were collected through personal visits to commercial orchard owners throughout the state. A tentative minimum of 100 bearing trees was fixed as determining a commercial orchard, but smaller orchards were considered if evidently of commercial importance. Approximately 1750 growers were visited, complete information on both trees and production being secured from about 1700.

The results of the study can not be fully stated here, but the following facts and figures give a summary of the situation as shown by the survey, so far as number of trees and plantings are concerned. It should be borne in mind that these figures relate only to orchards of commercial importance and do not include the trees in thousands of small farm orchards.

The owners of the orchards visited reported a total of 967,000 trees, over 600,000 of which were in bearing. More than seventy-five varieties were reported, but the principal ones together with the number of trees in each table are shown in Table 1. The Baldwin is by far the most important variety, having 45 per cent of the bearing trees and over 50 per cent of the commercial crop.

The McIntosh ranks second with 117,000 bearing trees or 20 per cent of the total, and 13 per cent of the apples grown. Nearly 85 per cent of the bearing McIntosh are under fifteen years of age, which accounts for the relatively low yield. In view of this fact and the large number of trees not yet bearing, the production of McIntosh apples may reasonably be expected to increase 100 per cent within the next ten years. Only 28 per cent of bearing Baldwin trees are under fifteen years of age, but there will probably be an increase of about 20 per cent in Baldwin production within the next decade. The early varieties such as the Transparent and Duchess are relatively unimportant both as to number of trees and production. Only about 5 per cent of all bearing trees fall within this class.

The Wealthy is third in importance so far as bearing trees are concerned, but the Gravenstein, with nearly the same number of trees, produces almost twice the crop. Coupled with the fact that many Wealthy trees are fillers, this gives the Gravenstein third place as a commercial variety.

New Plantings

The past ten years have been years of very heavy plantings, over 460,000 trees being set during this period. The plantings of Baldwins and McIntosh have been about equal. Since 1920, however, there has been a decrease in the rate of planting. From 1914 to 1919 approximately 95,000 McIntosh and 70,000 Baldwin trees were planted. During the period since 1920, there have been only 61,000 McIntosh and 55,000 Baldwins planted, a relative decline in planting, for the five-year period, of 35 per cent for the McIntosh and 20 per cent for the Baldwins. Plantings of all varieties have declined 20 per cent in the same period.

Of the winter varieties, the Delicious shows the greatest percentual increase in plantings, some 36,000 trees of this variety having been set in the last ten years, practically all being permanent. Other winter varieties have been planted in considerable numbers, the Wagener being a favorite. The older varieties, such as Greening, Spy and Russet, are rapidly disappearing, few new plantings being reported.

Fillers

The Wealthy is the variety most commonly planted as fillers. Out of a total of 34,000 bearing Wealthy trees, 15,000 were reported as fillers to be cut within the next five to eight years. In the younger plantings over two-thirds of the Wealthy are fillers. Relatively few McIntosh have been set as fillers, and where this was done some years ago, growers are cutting out the permanents and leaving the McIntosh. Wagener is also popular as a filler, nearly all the Wageners planted being used for that purpose. Duchess and Transparent have also been used in some quantities, about one-third of the bearing trees of these varieties being fillers.

Table 1. Number of Bearing and Non-Bearing Trees of Leading Varieties, 1925.

Variety	Non-Bearing			Bearing		
	Perm'ent	Filler	Total	Perm'ent	Filler	Total
Summer Varieties:						
Transparent....	5,095	1,648	6,743	6,673	2,811	9,484
Astrachan......	5,458	631	6,089	7,003	398	7,401
Williams.......	2,141	108	2,249	4,567	590	5,157
Duchess.......	5,148	3,898	9,046	7,149	3,836	10,985
Other.........	971	79	1,050	1,795	64	1,859
Total........	18,813	6,364	25,177	27,187	7,699	34,886
Fall Varieties:						
Gravenstein....	20,447	392	20,839	28,525	60	28,585
Wealthy.......	11,356	18,059	29,415	19,987	15,147	35,134
McIntosh......	111,656	5,188	116,844	112,980	4,432	117,412
Other.........	7,381	481	7,862	15,029	2,643	17,672
Total........	150,840	24,120	174,960	176,521	22,282	198,803
Winter Varieties:						
Baldwin.......	108,085	200	108,285	277,338	1,228	278,566
Spy...........	3,161	5	3,166	7,608	145	7,753
Delicious......	31,457	1,228	32,685	9,325	45	9,370
Greening.......	2,116	....	2,116	11,304	242	11,546
Other.........	18,773	1,391	20,164	67,844	2,181	70,025
Total........	163,592	2,824	166,416	373,419	3,841	377,260
Grand Total.....	333,245	33,308	366,553	577,127	33,822	610,949

Table 2. Number of Trees by Age Group, 1925

Age—Years	Perm'ent	Filler	Total
Non-Bearing:			
Under 5	180,482	21,545	202,027
5–9	150,470	11,763	162,233
Old	2,293	....	2,293
Total	333,245	33,308	366,553
Bearing:			
Under 10	85,883	11,256	97,139
10–14	164,993	19,997	184,990
15–19	60,351	2,114	62,465
20–29	55,991	391	56,382
30 or over	133,133	15	133,148
Unclassified	76,776	49	76,825
Total	577,127	33,822	610,949

Table 3. Number and Age of Trees in Summer, Fall and Winter Variety Groups.

Age—Years	Summer	Fall	Winter	Total
Non-Bearing:				
Under 5	15,141	93,490	93,396	202,027
5–9	9,987	81,363	70,883	162,233
Old	49	107	2,137	2,293
Total	25,177	174,960	166,416	366,553
Bearing:				
Under 10	9,602	55,970	31,567	97,139
10–14	13,215	89,206	82,569	184,990
15–19	3,964	20,448	38,053	62,465
20–29	2,433	11,306	42,643	56,382
30 or over	3,658	9,023	120,467	133,148
Unclassified	2,014	12,850	61,961	76,825
Total	34,886	198,803	377,260	610,949

THE VALUE FOR MASSACHUSETTS OF SOME OF THE NEWER VARIETIES OF APPLES

BY J. K. SHAW

The question of the best varieties of apples for planting will never be settled. While it is true that we have too many varieties and that nearly every fruit grower has in his orchard varieties that never should have been planted, yet no variety is perfect and the alert grower is constantly on the watch for something better. Then too, conditions are constantly changing and a variety that is quite satisfactory now may not meet the demands of the situation a few years hence. The man who anticipates the opportunity of a new variety and plants it early will receive the largest rewards; but on the other hand one who plants largely of a new variety that does not fulfill its early promise may suffer material losses. The choice of varieties is a most important question, for mistakes are not easily corrected.

Several varieties are now on trial in Massachusetts, and the following comments based on observations in the Experiment Station orchards and on the experience of others in this and other states is offered for the information of orchardists.

Cortland

The Cortland is a cross of Ben Davis and McIntosh originated at the New York Experiment Station. It has been considerably planted in New York where it seems to be meeting increasing favor. The supply of nursery trees has been limited, but nurserymen are now propagating them in greatly increasing numbers and liberal supplies of yearling trees are now available. More than 35,000 trees of this variety were certified by the Massachusetts Fruit Growers' Association in 1925.

Cortland is naturally compared with its parent McIntosh. Our experience indicates that in Massachusetts it will hang to the tree much better than McIntosh and need not be picked until at least two weeks later. It matures in storage later and will keep from one to two months longer. It stands handling distinctly better. Its susceptibility to Scab is no greater and may be a little less. The hardiness, vigor and growth habit of the tree are very satisfactory. It comes in bearing early and bears annually while young, and the fact that both parents tend to be annual bearers encourages the belief that it will keep up this habit very well with age.

It has the same white tender flesh as the McIntosh but is distinctly inferior in flavor. It lacks the spicy richness of its parent variety. It is, however, a good apple, probably equal and possibly superior to Baldwin. In appearance, while a handsome well colored apple, it is hardly equal to McIntosh and it appears to be less uniform in size and shape. Our judgment is that it will not replace McIntosh in New England though it will find a place in extending the McIntosh season.

Delicious

The Delicious has enjoyed an increasing favor over wide areas as a high class dessert apple. It is worthless for cooking purposes, unless for pies, so that fruit not attractive for fruit stand trade is good only for cider or similar uses. It has been considerably planted in Massachusetts, and its behavior is variable. In the Experiment Station orchards it tends to run small and of rather poor color after a few years' bearing. It bears heavily biennially. It seems to be more generally successful in Norfolk, Plymouth and Bristol counties than in the rest of the state. In western Massachusetts it does not do very well.

The tree is vigorous, upright spreading in habit and considerably hardier than Baldwin. It makes a rather dense head but after it reaches bearing age it is not objectionable in this way.

Probably the Delicious is more uniformly successful in other sections than it is in New England. If this is true it is doubtful if it ever attains here a place comparable with that of Baldwin and McIntosh. Possibly increased knowledge may lead to better management that will overcome its tendency to run small on mature trees. Thinning and nitrogen applications in midsummer may prove to be means to this end.

It follows that Massachusetts growers should use some caution in planting Delicious, at least until means of attaining uniformly high quality are more certainly known. No one may wisely plant it unless he is prepared to grow it skillfully so as to produce a high quality product that will meet the demand for a fancy dessert fruit. It is not a variety for a careless grower.

Golden Delicious

Much interest has been excited about the Golden Delicious, due to the extensive advertising it receives from the nursery firm introducing it. As grown in the Middle West it is a handsome waxen yellow apple of excellent quality. The tree is vigorous and begins to bear at a remarkably early age. It is apparently very productive. The apple hangs well to the tree and keeps and stands handling very well. In the humid climate of New England it does not seem to attain this clear waxen color, it is a more dull yellow and a little inclined to russet. It is doubtful if it attains the size it does where the growing season is longer.

Most of our New England markets have a distinct prejudice against yellow apples. This may be foolish, but it must be taken into consideration by fruit growers. Probably the extensive advertising this variety is receiving will go far towards overcoming this prejudice, but unless it succeeds better than preliminary observations indicate we cannot compete successfully with Golden Delicious grown in other sections where it attains greater attractiveness and possibly better quality.

Red Bud Sports

Many cases are known where a single branch on a tree normally bearing striped or splashed apples has produced fruit of a distinctly more intense red color, and this character is uniformly transmitted by buds taken from these branches. In other respects it is generally exactly like the parent variety. Many such "bud sports" of the Gravenstein have appeared in this state and elsewhere, and Rome, Twenty Ounce and other varieties show them occasionally. None of these red sports has attained very great favor with growers.

Recently a bud sport of the Delicious has been brought strongly to the attention of fruit men under the name of Starking. It is beyond doubt a true red bud sport of distinctly deeper color than Delicious usually has.

yet well colored Delicious may equal Starking in color. The deeper color of the new variety ought to be an advantage and if it is equal to Delicious in all respects, as may reasonably be expected, it may largely replace the parent variety.

Another red sport is the Red Spy, a solid red variation of the Northern Spy. It is reputed to be exactly like the old variety except in color. There is a question if it is more attractive in appearance than the best of Spies, yet it is well worth a trial by the patient fruit grower who wants to grow Spy.

Many red sports of Gravenstein have appeared, not all alike. One of the most recent ones is distinctly redder than others, being equal to the best colored Williams. As eastern Massachusetts is about the only fruit growing section, outside of California, that grows Gravenstein, this red sport should appeal to our growers who desire higher colored fruit.

DISEASES OF FRUIT IN MASSACHUSETTS IN 1925

BY WILLIAM DORAN

The Department of Botany of the Massachusetts Agricultural Experiment Station receives many requests for information on the identification and control of plant diseases. On such correspondence and on farm visits by the staff, is based this estimate or composite of the occurrence and severity of fruit diseases in 1925. As is developed below, fruit diseases in general probably caused less loss than usual.

Spray Schedule and Spray Materials

In most commercial orchards in Massachusetts the spray schedule on McIntosh consists of the following applications: pre-pink, pink, calyx, first post-calyx, and (in some orchards) a second post-calyx. Baldwins and other varieties considered less susceptible to scab, are given the pink, calyx, and first post-calyx application. In the case of "off-years" when certain varieties are not bearing, the number of applications is much reduced or perhaps none is given.

The favorite material is liquid or dry lime-sulfur. A few orchardists are partial to Bordeaux mixture for the pre-blossom applications. Those who own dusters are using sulfur dust for all applications or for the calyx and post-calyx applications only, depending on the sprayer for pre-blossom applications. Wettable sulfur (such as dry-mix sulfur-lime) is preferred by a few. Calcium caseinate spreader (such as "Kayso" or "Spracein") is generally used in the lime-sulfur-lead arsenate combination.

Scab of Apple

Most orchardists are familiar with the fact that the first infection of apple scab may occur when spores are ejected from the dead leaves in which the fungus has passed the winter. In 1925, in the Nashoba area, such spores were first ejected between April 29 and May 1. In this same region, this critical date was April 26 in 1921, May 2 in 1922, May 3 in 1923 and May 3 in 1924. It is thus seen that for five successive years this date has occurred about May 1 and within a range of eight days. We would expect it to be slightly earlier in southeastern Massachusetts and somewhat later in the highlands of Worcester County and the counties to the west, exclusive of the Connecticut Valley.

Apple scab this year was on the whole of average, or perhaps slightly less than average, severity, as indicated by the condition of the fruit on unsprayed or poorly sprayed trees. Good spraying gave practically complete protection even on McIntosh and other susceptible varieties. West of the Connecticut Valley there was a light infection on Baldwins. In the Connecticut Valley, the disease became conspicuous later than usual and in some orchards was regarded as severe on McIntosh and Delicious. There was evidence that the second post-calyx application on McIntosh gave some increased protection. In eastern Massachusetts some orchardists had as much scab on Baldwins as on McIntosh, or more. This was, perhaps, due to the fact that in many orchards the Baldwin received only one pre-blossom application while the McIntosh had two, and to the fact that many of the Baldwins are old and tall trees and consequently more difficult to spray well. In most orchards scab became conspicuous on the fruit in July and continued to increase until into September.

Spray Injury

The occurrence of spray injury is affected by the materials used, the manner of application, the susceptibility of varieties, and the weather at the time of and following the application. This being the case, it is not surprising to find that there was serious spray injury this year in some orchards and none at all in others.

In some orchards there was considerable spray injury on the fruit of Baldwin. But the most severe injury was on McIntosh, fruit russeting proceeding so far as to cause the fruit to crack. Leaf injury, in the form of curling, yellowing, or burning of leaf margins was in some cases associated with fruit russeting. This was easily confused with a condition which occurred on the leaves of certain young and unsprayed trees where the leaves showed a brown or blackened margin, probably caused by the high temperatures and drying winds to which these leaves were subjected during their period of development before the tissues hardened.

Spray injury as it occurred this year has been ascribed to the use of the spray gun, to the high temperatures which prevailed during the spraying season, to the use of fungicides containing copper, and to arsenical injury. The worst spray injury brought to our attention occurred in orchards which received pre-blossom applications of Bordeaux mixture or copper dust, with sulfur fungicides used for the calyx and post-calyx applications. Evidence was secured in 1924 that even for pre-blossom applications copper fungicides are less safe than are sulfur fungicides. As recorded by the present writer in Massachusetts Agricultural Experiment Station Bulletin No. 222, there was an average of 14 per cent russeted McIntosh apples on plots which received pre-blossom applications of Bordeaux mixture, and less than 1 per cent on plots which received pre-blossom applications of lime-sulfur. This year, there was of course some spray injury in certain orchards where only sulfur fungicides were used. Some of this may have been due to the use of a spray gun close to the trees and to the unusually high temperatures during the spraying season. During the first ten days of June the temperature was very high, with the maximum above 90° F. for four days in the eastern half of the state. In their study of foliage injury by arsenical sprays, Fernald and Bourne found (Mass. Agr. Exp. Sta. Bul. No. 207) that it is not safe to spray the apple when the temperature is 90° F. and the relative humidity above 67 per cent. It is therefore reasonable to ascribe some of the injury this year to arsenical burning, for this temperature and humidity combination was reached or exceeded during the spraying period in early June.

Black Rot

Black rot of the fruit of the apple was not generally serious this year, although certain individual growers considered it more serious than in 1924. It was reported on Baldwin, Greening, and Yellow Transparent, and was most common on Baldwin. Black rot was not serious even on fruit which showed severe spray injury. This is of interest since in some seasons black rot has been associated with or has followed blossom-end injury due to the calyx spray.

Black rot canker is the most common of the limb cankers, but in most commercial orchards it is not serious. It is often present on old Baldwins, and failure to spray and prune such trees properly results in its rapid increase in severity. Occasionally this disease causes serious loss in young and apparently well cared-for orchards, but such a condition is exceptional in this state.

Cedar Rust of Apple

This disease was practically absent or existed only in traces (and then on Wealthy) in the Nashoba district. Most orchardists have seen to it that red cedars were removed. There was light infection on Wealthy and Banana in western Massachusetts. The sporidia or spores by which this fungus passes from cedar to apple require water for their dissemination, and during that period in spring when this ordinarily occurs the rainfall was deficient.

Sooty-mold and Fly Speck

This disease was of no great importance this year. It was observed in a few instances on Baldwins and Greenings. It occurred more or less throughout the state, but, except on unsprayed and unpruned trees, it was of no consequence. Ordinarily there is more of this disease in the eastern than in the western part of Massachusetts. It may often be seen on drop apples which have remained long on the ground even when not evident on the fruit on the tree.

Baldwin-Spot

This disease, which also goes under the names of stippen or bitter-pit, is well known to orchardists. Unfortunately its cause and control are obscure.

Baldwin-spot was of somewhat more than average severity this year. In many orchards this was the "off-year" for Baldwins, and the disease was generally associated with a light crop and consequently larger fruit. It was not conspicuous in orchards where the fruit was smaller. The occurrence of the disease has an evident relation to alternate bearing and to thinning. Baldwin-spot may occur on other varieties, but this year it was called to our attention only on Baldwin and Stark.

Fire Blight of Apple and Pear

In eastern Massachusetts fire blight occurred about as usual in most orchards, although from a few orchards there were reports of its being on the increase, especially on Gravenstein and Wagener. In well cared-for orchards the removal of the more susceptible hosts has helped to reduce the menace of this disease.

In western Massachusetts, where the disease on the whole was not of great importance, it was present in a few Baldwin and young Wealthy orchards. In a few orchards in the Connecticut Valley it was serious, much more so than in the orchards of eastern Massachusetts with which we are familiar.

Fire blight on pear occurred throughout the state in varying degrees of severity, from serious in some orchards to none at all in others. It was more general on odd or unimportant varieties than on the standard or commercial varieties. It was observed that unnecessary pruning of healthy trees is likely to be followed by an increase in fire blight.

Other Diseases of Pear

Pear scab was severe in some unsprayed orchards, and if the pear increases in commercial importance here, more attention will need to be given to protection against this disease.

Black rot was reported in a few cases on Bosc pears.

Diseases of Peach

Leaf-curl of the peach was not as bad as usual this year. The ordinary dormant spray of lime-sulfur gave practically complete control, but in certain orchards where this application was not given, the disease was severe.

Brown rot of peach (and plum) was generally present although varying in severity in different orchards. In general, severe orchard infection was not apparent, and the ordinary use of sulfur fungicides, either sprays or dusts, gave a good control. But rotting of the fruit in the market due to this disease was often very bad. Brown rot was more severe on early than on late varieties of peaches. In some cases it was very severe on plums.

Miscellaneous Diseases

Downy mildew of grape was more than usually common. If grapes increase in commercial importance in this state, this disease will be one of the principal enemies of the crop. Fortunately, control by copper fungicides is not ordinarily difficult.

Mosaic of raspberry is of general occurrence. Its effects are becoming more conspicuous each year. The most practical action to take against it consists in the purchase of plants known to be free from the disease.

A root-rot of strawberries was rather common on second-year beds in early summer. Various soil fungi were found associated with it, but it is believed that they were only weakly parasitic and that the primary cause was connected with lack of soil moisture.

ORCHARD INSECT PESTS OF 1925

BY A. I. BOURNE

Perhaps the outstanding feature of the first part of the season was the early transition from winter to spring conditions. This was so marked that at the close of March it was estimated we stood fully two weeks in advance of the normal seasonal development. Although this progress was somewhat slowed up by unfavorable weather conditions encountered in April and May, yet this initial advance was not wholly lost throughout the rest of the season. Sensitive as we have found insects to be to varying weather conditions, it was but natural that we should expect them to commence their activities at a correspondingly earlier date. This is what actually happened.

Orchard Plant Lice began hatching during the last week of March, the earliest record since 1921. Reports from all parts of the state showed them present in unusual abundance. In some orchards they were out so early that the dormant oil sprays nearly wiped them out. They remained very abundant until the long-drawn-out period of cold, unfavorable weather the latter part of April, after which they practically disappeared from the orchards. Many growers found so few plant lice that they omitted the nicotine from the pink and calyx sprays. There were occasional small local outbreaks reported late in the season. These were confined chiefly to young trees, and even then were not a serious factor.

Leafhoppers, so prevalent in 1924, were practically absent from orchards this season. In many cases, where a year ago it was possible to find thirty or more young hoppers on a leaf, this season it was almost impossible to find any. In some orchards where for years they have been considered to be one of the worst pests, they were almost entirely absent this season.

One pest which was still rampant, and offers as yet no sign of relief, was the Apple Tent Caterpillar. From all parts of the state, it was reported as at least as abundant as last year. It is certainly true that, from Worcester County west, this insect is still on the increase. While it was in great abundance on roadside trees and on uncared-for apples in pastures, it also had worked into the orchards, and its control often became a real factor to be considered. Careful attention to this pest in the pink spray was found to control it.

The European Red Mite, in the early part of the season, did not appear to be very abundant. The widespread use of oils the previous spring had apparently so reduced it in numbers that many growers did not give it special attention. During the late summer, in the eastern part of the state especially, a rather heavy infestation developed, which increased rapidly so that, by the middle to last of August and into September, considerable bronzing of foliage resulted. This appeared to some extent in other parts of the state, especially where oil sprays had been omitted in the spring. Some growers expressed the opinion that this heavy attack of mites, late in the season, caused an early dropping of fruit.

No reports of any serious abundance of Red Bugs were received, nor did personal visits to the orchards bring to light any cases of severe injury. Apparently, over the state as a whole, it was either considerably below normal in abundance, or else so well controlled by the spray program followed that it was checked almost at the outset.

The Round-headed Apple-tree Borer continued to be a very serious factor especially in some of the orchards in the western part of the state, although found to be present to some extent in orchards in other sections. This insect does not appear to fluctuate as do many of our pests, but holds very regular in abundance year after year. When it offers any real problem, careful and repeated "worming" of the trees over a period of years enables the grower to gradually bring it under control, or at least materially reduce its abundance.

The Apple and Thorn Skeletonizer in its first two broods proved to be slightly less abundant than usual. It has been our experience, in Massachusetts, that the worst trouble has come from the larvae of the brood maturing the last of July and early in August. This season, this brood was much smaller than usual, and little or no injury was noted. The generation of larvae which came to maturity in early September proved, however, to be unusually large, and a considerable amount of late skeletonizing resulted all over the state. Coming so late in the season, this caused very little concern, and few, if any, of the growers deemed control measures to be necessary.

Over the state as a whole, the San José scale appeared to cause little damage. For the last few years, however, complaints of an increasing local abundance have come in from many points in the state. In some orchards it has developed into a real problem for the grower to face. The rapid spread of the Red Mite and consequent increased use of oil sprays in the dormant season have very often automatically solved the problem of the control of this scale. When, as frequently happens, a grower finds scale in any amount on his harvested fruit, he should use prompt measures for control in his orchard. Oyster-shell Scale is very generally present in practically all of our orchards, but seldom, if ever, is found in destructive abundance.

Early indications, borne out as the season developed, were that the Gypsy and Brown Tail Moths, if present at all in the orchards, were in such small numbers that they constituted no real problem for the growers Treatment of the overwintering egg masses of the Gypsy Moth was practically the only real control measure required.

This year the Plum Curculio began to appear in the orchards very close to the time of the calyx application. This was some two weeks earlier than it appeared in 1924. From the first it gave every indication of even greater abundance than in 1924. While in the best cared-for orchards its injury was held within moderate bounds, this insect still stands as one of the most serious of our orchard pests. It occurs with such regularity, year after year, that unless unusually hard hit, the grower has come to take it for granted, and therefore it is difficult to estimate accurately its relative abundance. It is, without any question, everywhere a serious pest; causes a large annual loss to the growers; and as yet is still far beyond successful control.

The Codling Moth was more abundant than usual over the state as a whole. Through the large fruit growing section in the eastern part of the state, it was often reported to have been the worst pest of the season. There was a considerable amount of early "side worm" injury from late hatching larvae of the first brood. In late summer, there was a very general and unusual amount of damage from second brood larvae. A study of the spray program followed by many of the growers showed very clearly that, where the calyx spray is carefully applied, growers are able to eliminate "blossom end" injury almost completely. Where one or two post-calyx applications have been made to cover fruit and foliage at the time the young larvae are hatching and infestation of the fruit taking place, it has been found possible to secure a very large measure of control. This past season an unusually large second brood developed, which caused much late "side worm" trouble. This was undoubtedly due to a very great extent to the fact that the first brood larvae matured and began leaving the fruit to spin cocoons, earlier than usual. Consequently a larger percentage pupated and formed second brood moths. It should be noted that growers who made one or two post-calyx applications of spray or dust, and followed these with an application early in August, suffered very slight loss from "side worms," either early or late. It is increasingly evident that, for the control of this pest, attention to the post-calyx applications is as necessary as to the calyx spray itself.

In late summer there appeared in all parts of the state an unusually heavy attack of the Apple Maggot or Railroad Worm. Others of the northern fruit growing states encountered a similar outbreak. The attack was somewhat uneven in its intensity, although no particular region of the state entirely escaped. It developed to serious proportions rather late in the summer, and, of the chief commercial varieties, the Wealthy appeared to suffer the worst, while McIntosh and even Baldwin in some cases were severely attacked, and one case of severe injury to Ben Davis was reported. This outbreak appeared so suddenly that many growers were unaware of its serious nature until the fruit began to be harvested and moved into the market; one result of which was that the market became rather suspicious, particularly of Wealthies. Whether this insect will be present in such numbers another season, it is impossible at this time to forecast. Growers should keep a sharp lookout in their orchards next season for the appearance of the adults, to determine the danger of attack. Careful disposal of cull fruit after a season of such unusual abundance is particularly stressed, to offer the least opportunity for the concentration of maggots in or near orchards.

The season was not marked by any serious outbreak of what may be classed as lesser fruit pests. Pear Psylla was present to the usual extent, but rarely in serious numbers. The Peach Tree Borer, largely because of the success of the Paradichlorobenzine treatment, has been reduced to a pest of but secondary importance. Fall Webworm was present in about normal abundance. When the fruit came to be harvested and graded, there was found to be an unusual amount of late injury by the Lesser Apple Worm and Red-banded Leaf Roller. This was noticeable on Baldwins especially.

The season was marked, however, by local outbreaks of some insects not usually found in abundance.

Early in the season, from several points in northwestern Worcester County, Climbing Cutworms were found to have been unusually abundant. On young trees especially, their injury was often severe. Young opening buds were devoured by these larvae, which from their habit of feeding at night and hiding by day gave no inkling of their presence until much of their damage was done. Many small, recently set trees were completely denuded of buds; others, not so severely attacked, lost such a proportion of buds that they were able to make but a feeble start, and were checked more or less through the season. Less severely injured trees were usually able to overcome this early setback and make a fairly normal growth. In some cases, not only were the buds completely devoured, but the hungry cutworms gnawed the tender bark just around them, clear in to the wood.

Somewhat later in the season, a few cases were noted of Click Beetles also gouging into buds and opening flowers. This injury, too, was most noticeable on young trees, but in no case as severe as that noted above, caused by Cutworms.

Early in June, reports of an outbreak of Pear Midge were received from points in Plymouth and Barnstable counties. As far as could be learned, this was not general, but was confined to local outbreaks in that region. Where the pest was reported, however, it was found to be causing severe damage. In some cases, over 50 per cent of the crop was estimated to have been attacked. Clapp's Favorite and Beurre Bosc were the two varieties specifically mentioned as being the most severely infested.

During late September and early October, there was discovered some injury to fruit caused by the so-called Dock False Worm. In one orchard, at least, larvae of this Sawfly were found to have bored into the fruit in considerable numbers. This was noted especially on Baldwins. Through the summer this insect feeds mainly on species of dock, sorrel, etc., and attacks fruit only in the fall when it seeks quarters for hibernation. The larvae bore into the fruit, making small round holes which soon show a slightly sunken, discolored ring on the surface of the apple. Inside the fruit these burrows run well toward the core, usually enlarged slightly toward the inner end where the small, light green larvae may be found. These entrance holes in the apples, while somewhat larger than those made by the Codling Moth, are probably often mistaken for those of that insect. As this insect is primarily a pest on different varieties of weeds, clean culture is obviously the best protection against it. In all probability this insect will seldom, if ever, become a serious pest in orchards. It is well for the grower, however, to be aware of its presence.

Taking the season as a whole, without any question the fruit growers' main troubles were caused by mid-season and late Codling Moth injury, the Plum Curculio and the Railroad Worm. Some of the pests commonly found in abundance were this season practically absent. On the other hand, one or two species, not usually found in numbers enough to warrant any attention from the growers, were encountered in considerable local abundance.

A survey of insect conditions made in the main fruit growing section of the state brought out very clearly the emphasis which should be given to careful and properly timed spraying. In spite of the diversity of insect attack which fruit growers encountered, it is significant that those who gave closest attention to spray or dust applications reported their orchards and fruit remarkably free from injury by insects. This was most noticeably true of those who gave particular attention to the post-calyx and mid-season applications.

PRUNING YOUNG APPLE TREES

BY J. K. SHAW

In the spring of 1916 an orchard of 600 one-year-old trees of Baldwin, Northern Spy, Rhode Island Greening, McIntosh and King were set ten feet apart, for an experiment in pruning with especial reference to head formation. Six different methods of pruning were arbitrarily chosen and consistently followed for a period of nine years. It is the purpose of this paper to present some of the conclusions reached from this experiment, that may be of value to the fruit grower. A more detailed report of the technical aspects of the experiment is in preparation.

The pruning methods chosen were as follows:—

1. The whips to be cut back at planting and the new growth cut back about one-half, the cutting back to be less severe in succeeding years. They were to be thinned out each year the same as the other types of pruning. The purpose was to produce a globular shaped tree, headed back annually.

2. Trees to be cut back at planting as in 1, and to be thinned out the same but not headed back. The purpose was to produce a globular headed tree not cut back.

3. The trees to grow without any pruning whatever except the removal of suckers and water sprouts.

4. The trees to be set without cutting back and the leader allowed to grow to a height of 7 to 8 feet and then suppressed if necessary. They were to be thinned out annually the same as the other types of pruning. The purpose was to produce a modified leader tree.

5. The trees to be set without cutting back, but to have all shoots except the leader headed back in later years, but a little less severely than the cut-back globular trees. The purpose was to produce a central leader tree.

6. The trees to be pruned as in 5, but without cutting back. The purpose was to produce a central leader tree without cutting back.

All trees except the unpruned were to be thinned out to about the same density, and two of the lots were to have the new growth cut back each year.

These five types of pruning were expected to produce, more or less successfully, three types of trees:—the globular headed tree generally preferred in Massachusetts, the modified leader type, and the central leader type. In 1922 when the type of tree was pretty well fixed, an estimate of the degree of success reached in securing these types was made, and the results are shown in Table 1.

Table 1. Degree of success in attaining the expected type of tree.

(Number of trees)

	Failure	Rather Unsuccessful	Fairly Successful	Successful	Highly Successful
Globular cut back....	0	0	5	26	68
Globular not cut back.	0	0	6	29	64
Modified leader.......	0	4	17	32	45
Central leader cut back	16	14	19	19	29
Central leader not cut back	24	23	26	17	10

This classification is, of course, wholly arbitrary and another observer might have classified them somewhat differently. Certain generalizations may, however, be quite safely made. It is evident that the globular headed tree may be more certainly secured than the central leader type and that cutting back the branches helps to produce a leader tree. The trees classed as failures were well formed trees and not by any means failures as orchard trees, but they did not have in any degree a dominant central leader. There was some difference in the five varieties used. Spy and McIntosh were rather more tractable than the other varieties, partly owing to winter-killing in the severe winter of 1917-18 which injured many Baldwins and Rhode Island Greenings and a few Kings. Several trees among the Baldwins, Spies and Kings were killed back to the snow line or severely checked by killing the wood while the bark and outer thin shell of wood remained alive. This doubtless interfered with the rise of water and checked growth for a year or two. Where they were killed back to the snow line a strong shoot arose in many cases and a good leader tree resulted.

The unpruned trees generally assumed a modified leader type and have naturally developed rather thick tops with many branches coming out of the central trunk.

Cutting back young trees is generally advocated, one object being to secure low headed trees. In 1919 measurements were made of the height of the lowest branches on these trees. The maximum difference between the average of trees cut back at planting and those not cut back was only about seven inches, a difference that is of no significance in mature trees.

An argument for cutting back frequently advanced is that it makes the tree, including the cut back branches, more stocky. It is now generally recognized that any increase in stockiness arises from shortening the branch and not from increased diameter. In the fall of 1923 the four largest branches on each tree of the Baldwins, Rhode Island Greenings and McIntosh trees were measured four inches from the trunk. The relative size of these branches is shown in Table 2, the unpruned trees being taken as 100.

Table 2. Relative size of branches of trees receiving different types of pruning.

	Baldwin	Rhode Isl'd Greening	McIntosh	Average
Unpruned	100	100	100	100
Globular cut back	121	123	139	128
Globular not cut back	144	131	139	138
Modified leader	114	103	118	112
Leader cut back	114	91	108	104
Leader not cut back	128	126	113	122

It will be seen that cutting back the side branches has not increased their diameter; but on the contrary, in all except the McIntosh, they are smaller on the cut back trees. The principal factor governing the size of the main branches is their number. The fewer branches there are the larger the four principal branches may grow; that is why all the pruned trees (except the cut back leader Rhode Island Greening) have larger main branches than the unpruned trees. It also explains why the four largest branches on the globular trees are larger than those on the leader trees; there are fewer additional smaller branches to compete.

After the growing season of 1924, when the trees had completed nine seasons growth, the height and spread of the trees were measured, and the average of all varieties for the several methods of pruning is shown in Table 3.

TABLE 3. Average size of trees at nine years old (feet).

	Height	Spread
Globular cut back	15.0	11.8
Globular not cut back	16.1	14.8
Unpruned	16.7	14.7
Modified leader	16.7	15.1
Leader cut back	17.0	12.4
Leader not cut back	16.9	15.5

This table shows that the leader trees are only a little taller than the globular trees. It is perhaps true that there will be more difference when the trees come in bearing, for the scaffold limbs of the globular headed trees may bend down with loads of fruit.

Cutting back the globular headed trees has made them a little shorter and both these and the cut back leader trees have less spread than the trees not cut back. It is now generally considered that pruning dwarfs trees, but these figures indicate that the rather light pruning practiced here has not dwarfed the trees much except where cutting back was practiced. Thinning out the top leaves the remaining foliage better exposed to the light and this may compensate for the reduction in leaf area from pruning.

The practice of cutting back new shoots annually on young trees was formerly quite generally advocated for young trees. Our experience with this orchard would lead us to avoid cutting back except where it is desired to dwarf one or more branches so that they will not outgrow other parts of the tree.

BLOOM AND YIELD

This orchard has not produced much fruit. None has been borne by the Northern Spy trees, and product of the Kings is negligible. The first crop of the other varieties was in 1922 and there has been a light to moderate crop each year since. The McIntosh trees have naturally borne the most, averaging over 4½ bushels per tree for the four years total crop. The average percentage of bloom and the total yield per tree is shown in Table 4. The most significant fact brought out is the effect of annual cutting back. It has decreased bloom in every case and decreased yield in all cases except the globular McIntosh. Probably the differences between the different types of pruning, not involving cutting back, and including the unpruned trees, are of no great significance. While the tops of the unpruned trees are pretty thick, no marked inferiority of the fruit in either size, color or quality has yet appeared.

The one-year whips set without cutting back made a very poor growth the first season. Most of them sent out two or three side branches not over a foot long. The second year these trees sent out additional branches, and, had it not been for the limitation imposed by the plan of the experiment, might all have been developed into strong well formed trees. Indeed, they are more satisfactory than are many commercial orchards.

TABLE 4. Bloom and yield, 1922-25 inclusive.

	Average percentage of bloom			Total yield, pounds per tree			
	Baldwin	R. I. Greening	McIntosh	Baldwin	R. I. Greening	McIntosh	Total, all varieties
Unpruned	4	13	29	48	55	197	300
Globular cut back	1	10	13	17	34	160	211
Globular not cut back	2	17	21	42	51	141	234
Modified leader	4	18	31	41	52	256	349
Leader cut back	1	16	18	9	32	140	181
Leader not cut back	2	24	28	32	34	223	289

The trees cut back at setting sent out three or four strong shoots. Generally one of these might have been developed as a leader had the plan of the experiment allowed. It is felt that a one-year tree may be cut back at planting or not as the planter desires, but if cut back at setting one shoot should be chosen and maintained as a leader for a few following years. In order to do this the other branches will require cutting back. If it is not cut back, growing conditions must be favorable and one should not be discouraged if rather poor growth is made the first season; it may be expected to be as large as, or larger than a cut back tree after two or three years.

During the three or four years while the leader is developing, several permanent scaffold branches should be selected. These may well be a foot apart even if on opposite sides of the trunk, for if too close they will check the growth of the leader. Not more than two or three satisfactory candidates for main scaffold branches can be expected during the first season of growth.

These scaffold branches should not be cut back except as necessary to keep them about the same size. To insure this equality will require some pruning, especially of the older, lower branches. Cutting back will be more effective than thinning out where it is desired to hold back a branch. It will be generally understood that these main branches should be well distributed around the tree as well as along the leader, in order to produce a tree equally developed on all sides.

The remaining branches not desired for permanent scaffold limbs may be cut out where they are too plentiful or cut back if necessary to keep them smaller than the permanent branches. They may then contribute to the growth of the tree and some of them may serve for a few years as fruiting branches, being removed when the growth from the permanent scaffold branches weakens them by stronger growth and consequent shading.

It is probably safe to urge that as little pruning as possible be given the growing tree and that only for the purpose of directing growth. We cannot in any practical way stimulate the growth of one part of the tree beyond the rest. The only way to keep the various parts of the tree symmetrical is to prune the part that is growing too fast. Probably cutting back is more effective than thinning out, when one is forced to check the growth of a branch that is outgrowing its neighbors.

Always one must prevent the development of equal forks. By this is meant forks of two or more branches of approximately equal size. Such unfortunate conditions are frequently found where a young tree is cut back at planting and the several branches that arise from the shortened trunk are allowed to develop equally. Sooner or later one or more of these branches splits off with a load of fruit, seriously damaging the tree. This condition is prevented if the side branches are kept subordinate to the leader by pruning or perhaps removing some of them. Similarly one must deal with equal forks wherever they appear in the tree. One branch should be cut back severely or entirely removed, and the earlier it is done the better.

EFFECT OF THE STOCK ON THE SCION

By J. S. BAILEY

The variability of seedling root stocks for the apple and the desirability of having trees propagated on vigorous roots have been recognized for years. But not until recently has experimental work been started to seek out desirable root stocks and practical methods of propagating them.

This is a report of progress of work being done at the Massachusetts Agricultural Experiment Station to ascertain the effect of several stocks on various scions and to find a hardy, vigorous, uniform stock suitable to be used in the propagation of our common commercial varieties.

To show the extreme variability in yield of apple trees propagated on seedling stocks, the following data have been taken from reports of the Pennsylvania and West Virginia Experiment Stations. Table 1 gives the total yield in bushels from 1908-1918 of individual trees in a York orchard planted in 1888 in Pennsylvania. The orchard was in sod and the trees whose yields are included in the table were all treated alike and had no fertilizer. The arrangement of the figures in the table corresponds to the location of the trees in the orchard.

Table 1

13 bu.	4 bu.	16 bu.	5 bu.		7 bu.	
24		41		50 bu.		35 bu.
41	34		20	30		
31		49	37	25	17	
15	25		14	17		

Some Grimes trees in a West Virginia orchard show even more striking contrasts. Of two trees growing side by side and getting exactly the same treatment, one yielded a total of 36 bushels and the other 3 pounds for a ten-year period. Still another pair yielded 38 bushels and 2 bushels for the ten-year period.

The Maine Experiment Station has concluded from data collected over a long period of years that in any one year 35 per cent of the variation in yield is due to seedling stocks and 65 per cent to soil differences.

With the object of eliminating the 35 per cent of variation due to seedling stocks, the Massachusetts Experiment Station started in 1912 an experiment to grow a number of varieties on known roots. That is, trees were started on seedling roots and after roots had been sent out from the scion, the seedling roots were cut off. These scion rooted trees were then used as the stocks in this experiment.

After the stocks had been obtained the orchard now known as the Root and Scion Orchard was planted in 1915. This orchard consists of over 1100 trees. The main part of the orchard, 685 trees, consists of the following top and root varieties:

Top Varieties	Root Varieties
Red Astrachan	Own rooted
McIntosh	Ben Davis
Yellow Transparent	Bough (Sweet)
Baldwin	Northern Spy
Wagener	Red Astrachan
Tolman	Wagener
	Wealthy
	Oldenburg (Duchess)
	Yellow Transparent
	English Paradise

The balance of the orchard consists of various other varieties on a number of different stocks.

The growth of the trees has already given us some striking results. Figure 1 shows the average trunk diameter in 1924 of the six main varieties on ten different stocks.

The first thing noticeable in this figure is the larger growth of the own rooted trees of the more vigorous varieties,—Red Astrachan, McIntosh and Baldwin. Special attention is called to McIntosh on its own roots, which is much superior to McIntosh on any other root. See Fig. 3, Plate I.

In contrast to the good growth of the own rooted trees, notice the very poor growth of all varieties on Oldenburg roots. This poor growth has been consistent throughout the experiment. It is probably due almost entirely to a lack of vigor of the stock although incompatibility of stock and scion may have had some influence also. Fig. 4, Plate I, shows a McIntosh tree on Oldenburg roots. Compare this with Fig. 3, Plate I.

The Northern Spy has always been considered a desirable stock in this country where it has been grown on seedling roots and then used for top-working. In South Africa and Australia where it has been used as a root stock to resist the attacks of woolly aphis, it is considered a dwarfing stock. In Fig. 1 it shows up as being fairly vigorous. Trees on this stock grew much more vigorously in 1923 and 1924 than previously. The weak growth of trees on Northern Spy during the first few years was probably due to Hairy Root, a form of Crown Gall with which most Northern Spy stock was infected. It is probable that the Northern Spy is a vigorous stock after it has grown sufficiently to overcome the effects of Hairy Root.

Crown Gall is not confined to the Spy stocks. Most of the others are infected more or less with some form of it. Data will be collected later to determine how much it has affected the results.

The Bough stocks show up in Fig. 1 rather better than the Northern Spy stocks. This difference will probably be reversed in the next few years, as the Bough stocks have behaved just the reverse of the Northern Spy. They were the easiest to root of any of the stocks and grew so well the first few years that they got a big start over most of the others. But the past two or three years the trees on Bough stocks have been slowing down in their growth as compared with those on most of the other stocks.

Tolman trees on their own roots are really not as poor, after they get

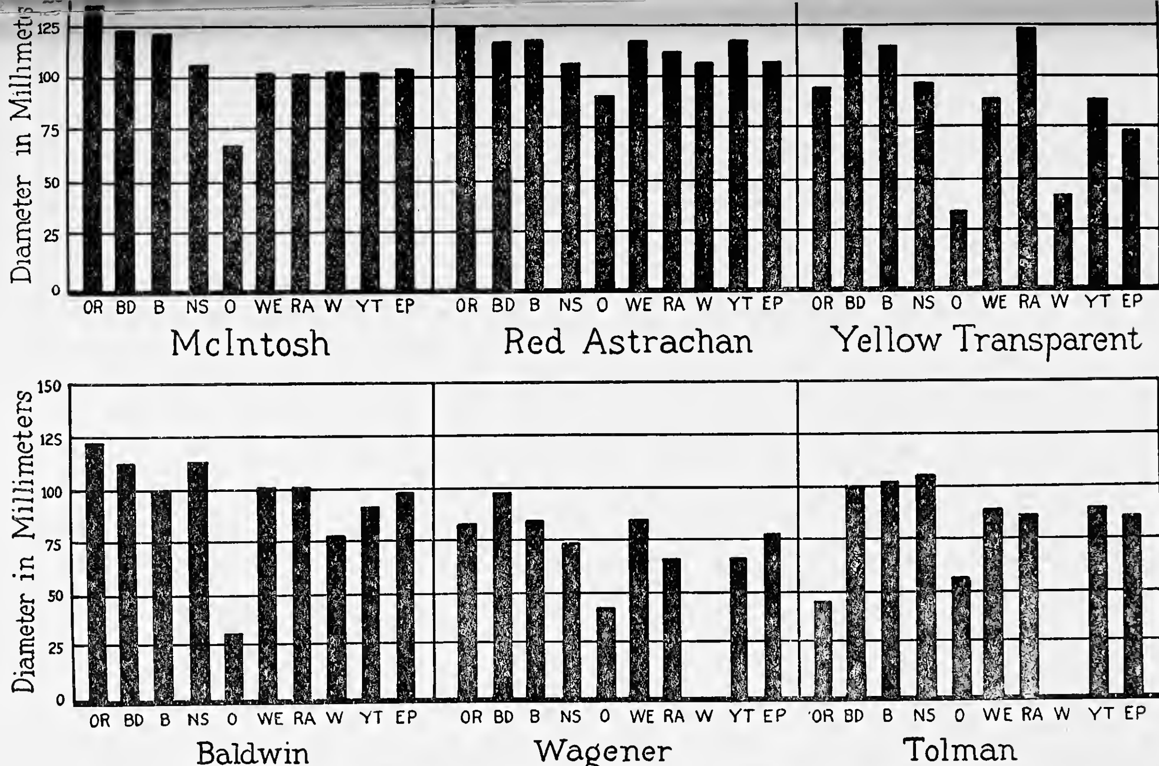

FIG. 1. Average trunk diameter in millimeters of the six top varieties on the several stocks—1924.

O. R.	Own rooted	N. S.	Northern Spy	R. A.	Red Astrachan	Y. T.	Yellow Transparent
B. D.	Ben Davis	O.	Oldenburg	W.	Wagener	E. P.	English Paradise
		B.	Bough	WE.	Wealthy		

started, as Fig. 1 indicates; for during the years 1923 and 1924 they made more growth than Tolman trees on any other roots. The difficulty lies in getting the Tolman roots started. This was the hardest of any of the varieties to root from the scion, and therefore was under a great handicap when the trees were set.

The English Paradise stocks have not done as well as Fig. 1 indicates. They made a fairly rapid growth at the start but slowed down very noticeably during 1923 and 1924. The tops are small and in some cases, such as with Tolman, show a very characteristic shape. (See Fig. 5, Plate II.) Notice the flat spreading character of the top. Compare this with the upright growth of Yellow Transparent on the same stock (Fig. 6, Plate II.)

In regard to the effect of the different stocks on bearing, no conclusions can be drawn at the present time as the trees have not borne enough crops to determine what their actual performance will be. Figure 2 shows the average total yield for the years 1922, 1923, and 1924.

This figure shows four things in regard to earliness of bearing. First, the dwarfing stock, English Paradise, brought most of the varieties into earlier fruiting than any of the other stocks. Second, Oldenburg stocks have not brought any of the varieties into early bearing. This is because the tendency toward late bearing, due to lack of vigor, completely outweighs the tendency toward early bearing, due to the dwarfing effect. Third, McIntosh on its own roots has borne earlier than McIntosh on any other root. This is due to the exceeding vigor of the McIntosh roots which have brought the tree to bearing maturity more quickly than any other roots. Fourth, the Northern Spy root has had the effect of a dwarfing stock on McIntosh and brought it into early bearing. As has already been pointed out, the growth records show that this dwarfing effect is not permanent.

From this work it is concluded that the effect of the stock on the vigor of the scion depends on (1) the vigor of the stock; (2) the readiness of rooting of the stock, though this is only temporary; and (3) "the degree of success of union between the stock and scions."

It follows, then, that a uniform vigorous hardy stock which can be propagated by vegetative means is needed to replace the seedling stock now in use for the propagation of apple trees. This problem has been taken up by the United States Department of Agriculture and the Pennsylvania Experiment Station, as well as by the Massachusetts Experiment Station.

In the spring of 1924 this Station imported from the experiment station at East Malling, England, 800 stocks of 17 types. These types had been selected from apple stocks commonly grown on the European continent. They range from very dwarfing stocks to free growing standard stocks, all of which, it is said, can be vegetatively propagated by means of mound layers. Some of these imported stocks were used for increasing the supply, and others were budded to McIntosh and Wealthy in August, 1924. It is hoped that among these stocks one or more will be found which fills the requirements of a good stock.

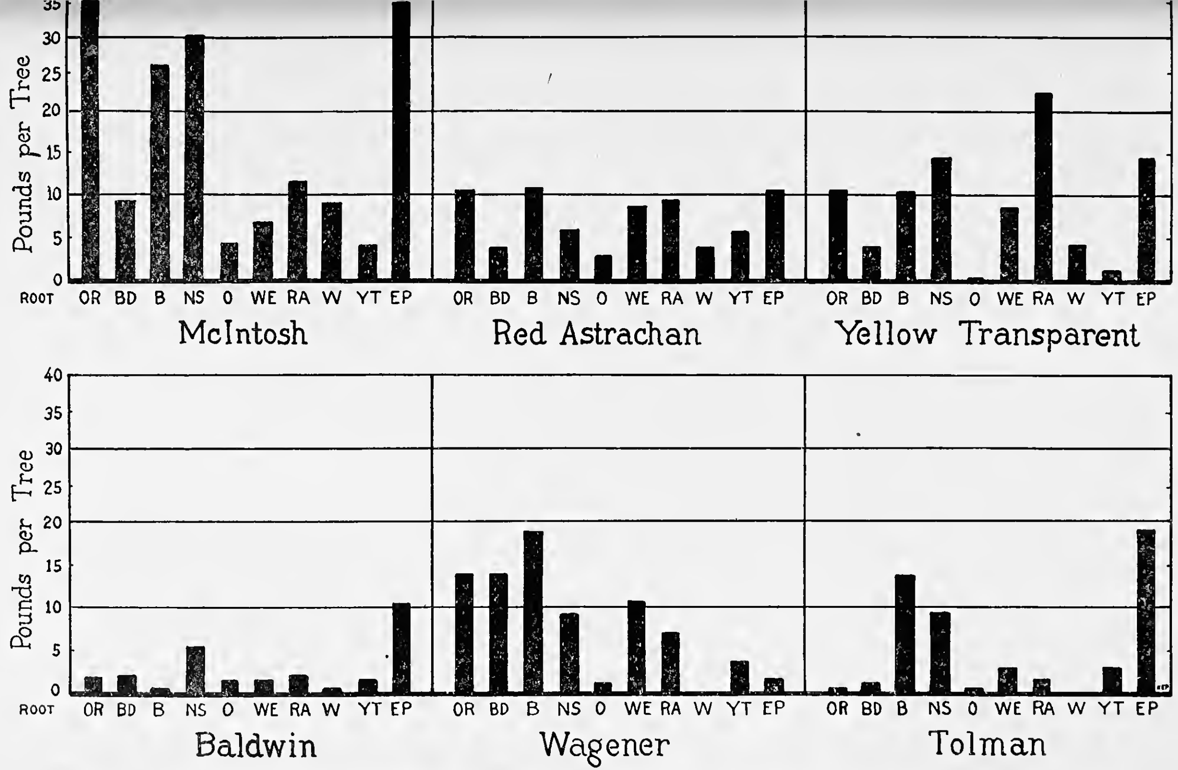

Fig. 2. Average total yield in pounds of the six top varieties on the several stocks—1922-1924, inclusive.

O. R.	Own rooted	N. S.	Northern Spy	R. A.	Red Astrachan	Y. T.	Yellow Transparent
B. D.	Ben Davis	O.	Oldenburg	W.	Wagener	E. P.	English Paradise
B.	Bough	WE.	Wealthy				

THE PROGRESS OF NURSERY TREE CERTIFICATION

BY J. K. SHAW

The certification of varieties of fruit trees for trueness to name rests on the possibility of recognizing varieties by the trees in the nursery row. That varieties could be so recognized has long been more or less well known to nurserymen.

Special studies of varieties of apple trees were begun at this station about 1912, in connection with the project for the study of the Interrelation of Stock and Scion in Apples. By 1920 the writer had become convinced that it was possible to detect misnamed trees in the nursery row with practical certainty. In June, 1921, a meeting was called to consider the possibility of certifying nursery trees and thus minimize or eliminate the misnamed tree that had been a source of considerable loss to fruit growers of Massachusetts and other states, also to nurserymen and tree dealers. At this meeting were representatives of the Department of Pomology of the College and Station, the State Department of Agriculture and the Massachusetts Fruit Growers' Association. The possibilities of certification were discussed and a tentative plan of operations outlined. At a meeting held at Amherst in August, 1921, the Massachusetts Fruit Growers' Association voted to sponsor this plan, and it was first put in operation in September, 1921, and has been continued on a constantly enlarging scale each succeeding year.

For the first two years, work was done in Massachusetts nurseries only. It soon appeared that little progress could be made unless the work was extended to nurseries outside the state, because only an insignificant portion of the trees planted in the state are grown here. Consequently arrangements were made in 1923 to certify trees for a western New York firm that sells a considerable number of trees to Massachusetts growers. In order to avoid a possible charge of favoring any particular nurserymen, certification was offered in 1924 to any nursery desiring it, and this policy has since been followed. The following table shows the development of the work:

Year	Number of Firms	Number of Trees Certified	Number of Trees Refused Certification
1921	1	2580	267
1922	2	8437	435
1923	3	65910	905
1924	6	125609	3505
1925	13	166810	9250
Totals		369346	14362

The nursery firms now cooperating in the certification work sell a large proportion of the trees bought by Massachusetts growers. It is therefore possible for any grower in the state to buy trees with this increased assurance of their being true to name. Too much stress should not be laid on the number of trees refused certification. While it is certain that practically every one of these was not true to the nursery record or label, many of them were known to the nurserymen and would not have been sold under wrong names; in most cases, however, it was a surprise to the nurserymen to learn of these misnamed trees. On the

PLATE I.

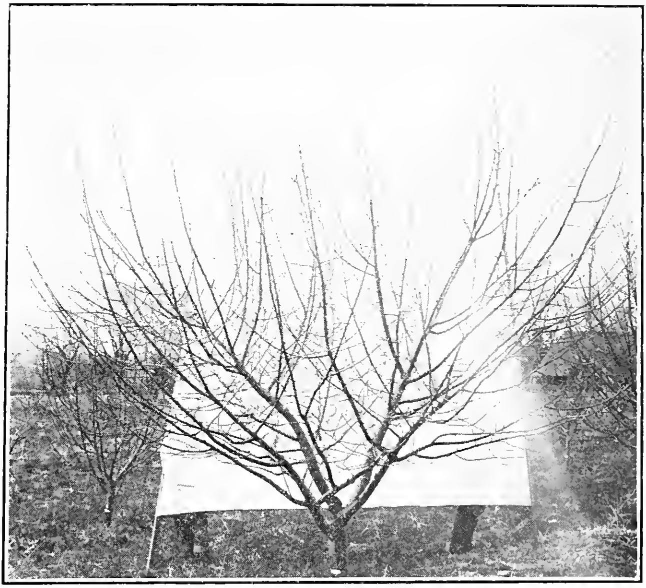

FIG. 3. McIntosh on its own roots.

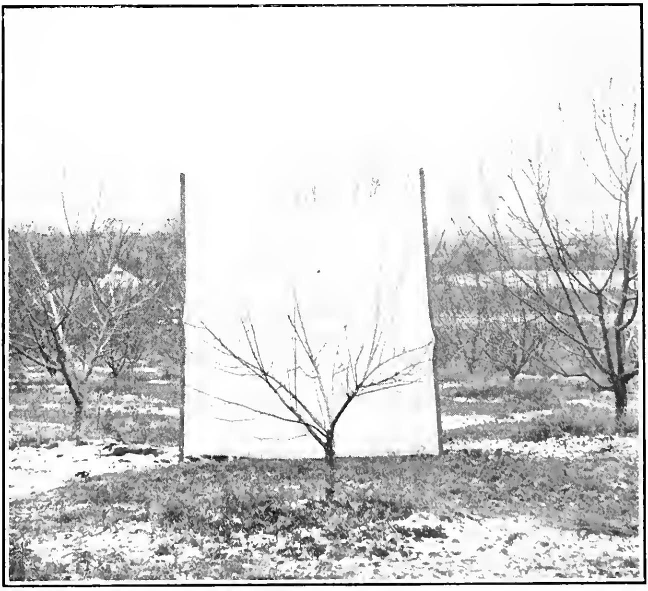

FIG. 4. McIntosh on Oldenburg roots.

(Figures 3 and 4 are on approximately the same scale. The apparent difference in the size of the screen is due to the fact that in Figure 4 the screen was held considerably farther from the tree than in Figure 3.)

Plate II.

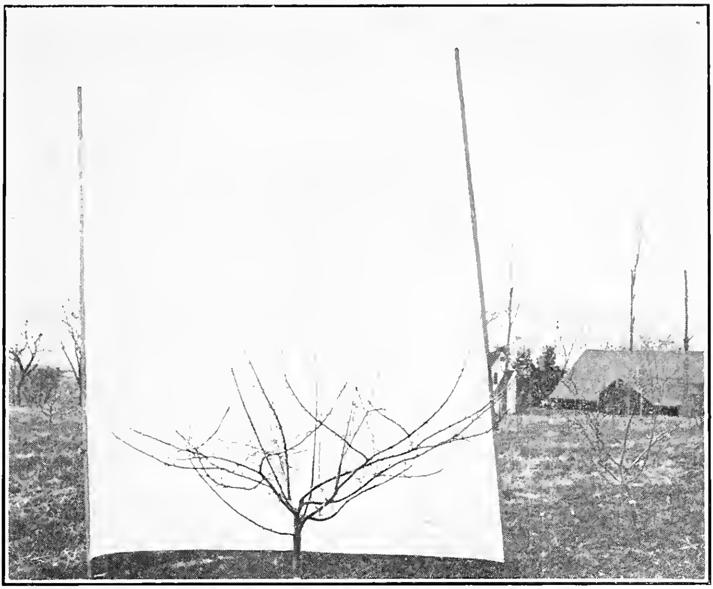

Fig. 5. Tolman on English Paradise roots.

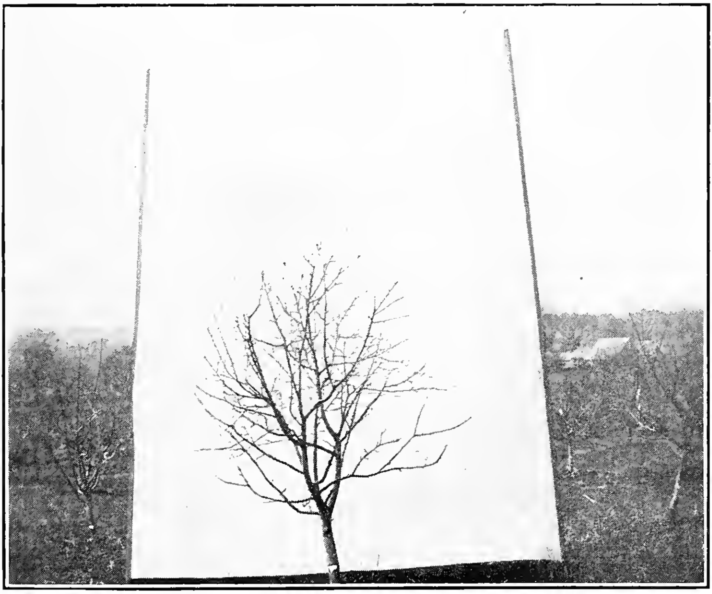

Fig 6. Yellow Transparent on English Paradise roots.

other hand, we have no means of knowing how many mistakes may be made in digging and shipping the trees. Such errors are absolutely eliminated with certified trees. Many more trees have been examined than certified and the misnamed trees among these are included in the above table.

Certification is carried on by the Massachusetts Fruit Growers' Association. The Experiment Station has no official connection with it though it has given moral support and cooperation. Any nurseryman desiring certification may apply to the Association and an agent qualified to distinguish varieties visits the nursery during the late summer or early fall and personally examines the trees. To such as are found to be true to name a lead seal is attached by drilling a one-sixteenth inch hole through a branch, or in case of one-year trees through the trunk. The name of the variety (usually in abbreviated form), the word "certified" and on the reverse side the letters "M. F. G. A." and the year in which the work was done are stamped on the seal with a hand seal press. *All trees certified by the Massachusetts Fruit Growers' Association bear this lead seal.* The work of attaching seals is done by employees of the nursery, working in gangs of four. One gang will seal from 2,000 to 4,000 trees per day. The cost of the work is met by the nurserymen. It has varied greatly with conditions, but with the larger jobs has probably been from $18 to $25 per thousand trees certified, including the cost of attaching seals.

For the first two years only two-year apple trees were certified but later one-year trees were included. The number of varieties has gradually increased until now nearly forty are included. Pear and plum varieties were taken on in 1925 though only a few trees were certified.

All nurseries examined thus far have contained trees not true to name, but the proportion has varied from less than 1 per cent to more than 10 per cent. As the work in any one nursery continues the number of misnamed trees naturally decreases, but new mixtures may appear from year to year.

This plan of certifying trees to be true to name is not infallible. It depends upon the human eye and brain and they are not perfect. The chances of error are, however, slight and it is confidently believed that the number of errors made is insignificant. No such cases have yet been brought to the attention of the Association. Variety certification is in operation in Canada and in California and is under consideration in other states. It is believed that it is the best plan of eliminating the misnamed tree yet brought forward. Every nursery firm starting the work has continued it in succeeding years.

THE CODLING MOTH IN MASSACHUSETTS

BY A. I. BOURNE

The codling moth is one of the worst insect pests with which orchardists of Massachusetts have to contend. In spite of thorough and careful spraying, the annual loss from its ravages continues very high.

The life history of the codling moth in Massachusetts has been approximately known for years, and general methods for its control practiced; yet fruit growers have been annually confronted with very considerable losses which have come mainly from so-called "side worm" injury. Such a condition of affairs led the Station to engage in a study of the insect, with particular reference to determining the proper timing of the "cover" sprays following the calyx spray.

It was at first supposed that this "side worm" injury was due almost altogether, if not entirely, to second brood larvae. Consequently attention was at first directed toward determining the approximate date when this brood appeared, and also its relative size and importance. As the project developed, it became evident that a more accurate knowledge of the entire life history of the insect was necessary, if a satisfactory solution of the problem was to be reached. Beginning with 1923, therefore, the complete seasonal history of the insect has been followed. Some of the more important events in the life history of the insect, as recorded for the three seasons, are summarized in the following table:—

Table 1. Development of the Coddling Moth, as recorded in 1923, '24 and '25.

	1923	1924	1925
Beginning of spring pupation	May 3	May 3	April 24
Date of last pupation	June 26	July 11	June 20
Duration of pupa stage	8-24 days	12-23 days	8-24 days
Emergence of first moths	May 27	May 24	May 12
First period of maximum emergence	June 2-4	May 26-30	May 16-18
Second period of maximum emergence	June 20-24	June 22-27	June 3-9
Date of last emergence	July 2	July 24	July 3
Duration of egg stage	5-10 days	4-12 days	4-11 days
Emergence of second brood moths	July 20-Aug. 29	July 21-Sept. 2	July 11-Aug. 28
Period of greater emergence	Aug. 3-6	Aug. 4-9	July 31-Aug. 12
Appearance of second brood larvae	Aug. 1-Sept. 6	Aug. 2-Sept. 17	July 24-Sept. 12

Comparison of the dates of the development of the insect, as shown in Table 1, with the seasonal development of the apple during the three-year period is noted below:—

Table 2. Comparison of the seasonal development of the apple with that of the codling moth.

Apple Development	Codling Moth Development
Blossom buds showing pink	Beginning of pupation
Pre-pink spray	———
———	Moths appearing (1-6 days before calyx spray)
Calyx spray	First period of maximum appearance of moth
3-4 weeks later (2-3 weeks in 1925)	Second period of maximum emergence of moth

In general the weather conditions prevailing during 1923 and 1924 were very similar, particularly as regards the frequently recurring periods of cold and unfavorable weather in May. These retarded the normal advance of the season and caused a corresponding slowing up of development on the part of the codling moth. In 1925 insect activities commenced fully a week to ten days earlier than in the two previous years, and held this advantage throughout most of the season. This difference is reflected in Table 1 above, where it will be noted that the dates of various steps in seasonal development of the insect for 1923 and 1924 were nearly the same, while in 1925 they were about ten days earlier. It naturally followed that first brood larvae began to mature and leave the fruit that much earlier than usual, so that a larger proportion formed pupae and emerged as second brood moths.

During the last three years it has been possible to follow the seasonal development of the insect in the eastern part of the state, through the assistance of Mr. A. N. Calkins of Harvard. Thus far there has been found to be very slight difference between the two points, a matter of two or three days in either direction being the most thus far noted.

In a survey of the results to date, certain outstanding facts are significant. There have been, each year, two widely separated and distinct periods of abundance in the emergence of first brood moths. The first coincides very closely with the time of the calyx application. By careful spraying at this period, growers have been able to practically eliminate "blossom end" injury, and cut down very largely the danger of a serious second brood.

In the last three seasons there has been a second great peak of abundance which, from our records, may contain the greater part of the total emergence. This second peak in 1923 and 1924 occurred three or four weeks after the first. In 1925 the period was shortened by the extremely hot weather early in June. The main damage caused by the codling moth at the present time appears to be largely due to this irregularity in the emergence of moths and consequent long-drawn-out appearance of first brood larvae. This causes the early "side worm" injury which has been so prevalent in late years.

It is clear that any spray to be effective under such conditions must be timed so as to kill a maximum number of larvae before they enter the apple, and emphasizes the need of the cover or post-calyx spray. This needs to be applied very thoroughly since we have found that young larvae, on their way to enter the fruit, will feed to some extent on the foliage. In the years 1923 and 1924, this would have properly been applied about four weeks after the calyx spray. In 1925, due to the speeding up of development from the hot week in June, this spray would have been timed about three weeks after the calyx spray. It is worthy of note that those growers who sprayed during or just after that week reported very clean fruit in those blocks treated.

As our knowledge of the habits of this insect develops, more than one spray during this period may be found advisable, to give continuous protection during the long period over which infestation of fruit may take place. A survey of some orchards in the main fruit growing sections of the state brought out the fact that growers who made two or more applications of either spray or dust at two-weeks intervals after the calyx application reported early "side worm" injury almost negligible.

Growers have come to believe that the calyx and one or two cover sprays after the calyx will so control the pest that the probability of a serious second brood can be ignored. Ordinarily this may prove true. In 1925, however, there developed a comparatively large second brood, throughout the state, with a serious amount of late "side worm" injury, due very largely to the reasons mentioned earlier in this paper.

From the data at hand, this second brood appears at about the same period every year, regardless of whether the season has been "early" or not. If the grower depends on a single application aimed to control the pest at this stage, dusting or spraying early in August would appear to give him best results. Some growers this season made an application at this time, and succeeded in reducing late "side worm" injury in those blocks very successfully.

For successful control of this pest, from our present knowledge of its life history and habits, certain steps are essential:—

1. A thorough application of the calyx spray. This is very important. Upon it depends freedom from "blossom end" injury, and lessening the danger of a large second brood.

2. The cover or post-calyx spray is almost equally important. It demands even more care from the grower as to the proper time of application. Upon this depends protection over the long period during which larvae are appearing, and relief from early "side worm" injury.

The exact date for this spray, and the number of applications that may be necessary cannot be stated absolutely. These must be determined each season, as they are governed largely by weather conditions From the experience we now have, two applications at intervals of two weeks after the calyx spray have given excellent results. A third application may be advisable should the season be unusually "early."

3. If the season is "early," there will be the probability of a large second brood. The bulk of this brood apparently comes about the first of August each year, whatever the type of season up to that time. With a brood of such size as that of 1925, a special application in early August is necessary to avoid serious late "side worm" injury.

TESTS OF LIME-SULFUR SOLUTION AND SOME OF ITS SUBSTITUTES AGAINST SAN JOSÉ SCALE

BY A. I. BOURNE

While under eastern conditions, at least, lime-sulfur solution has long been recognized as the standard dormant spray for the control of San José scale, yet fruit growers are much interested in the various dry powders now offered as substitutes for the concentrated solution. Transportation charges are less, there is no danger of freezing and no loss from leakage. Used in strengths recommended, these dry powders furnish less polysulfide sulfur than does the concentrated liquid used at standard dilution of one part to eight parts of water.

This situation led the Experiment Station to undertake a test of these different materials with the purpose of finding whether the dry materials are effective, and how dilute the liquid concentrate may be used and still be effective, for scale control.

All the materials used in the tests were of standard brands purchased in the open market. A chemical analysis of each brand was made, as shown in Table 1.

Table 1. Polysulfide sulfur and free sulfur in the materials tested.

	Polysulfide Sulfur, Per cent.	Free or Inert Sulfur, Per cent.
Lime-sulfur solution (33°+Beaume)	25+	—
Dry lime-sulfur	55+	6
Sodium sulfur compound	41+	3
Barium sulfur compound	21+	15

The materials were used at the strengths recommended by the manufacturers for scale control, and printed on the label or the container;

and were applied in liberal amounts to insure a thorough covering of all parts of the trees.

The materials were applied each year as "delayed dormant" sprays, and results were determined by microscopic examination of sprayed and unsprayed trees, the number of dead and living scales present being recorded. Counts were made a few weeks after the sprays were applied, but well before the time of appearance of the crawling young. During the course of the tests more than 10,000 scales were counted, this being the basis upon which conclusions were drawn as to the effectiveness of the different materials and dilutions.

Preliminary tests the first season indicated conclusively that dilutions of the liquid concentrate of 1 : 16 or beyond would not give satisfactory control of the scale. Further tests at or beyond this dilution were therefore omitted. The results of the three seasons' tests are summarized as follows:

TABLE 2. Results of tests with various sulfur sprays for the control of San José scale.

		Scale dead, Per cent.
Lime-sulfur solution	1 : 8	97
	1 : 9	97
	1 :10	97
	1 :11	95
	1 :12	94-95
	1 :14	86-87
Dry lime-sulfur		93
Sodium sulfur compound		92-93
Barium sulfur compound		90-91
Unsprayed check		74-75

It was noted, during the three seasons, that there was considerable variation in the percentage of scale which lived through the winter. This ranged from about 21 to 28 per cent, and seemed closely associated with the type of winter experienced. For the three-year period, the average winter mortality was close to 75 per cent, which figure is doubtless about what we may expect to occur under Massachusetts conditions.

This difference in the percentage of scales which died during the winter caused some variation in the estimates of relative efficiency of the sprays, from one year to another. Over the entire period, the relative control value of the different sprays as compared with the untreated checks is shown in the following table:

TABLE 3. Relative control value of the different sprays.

		Effective Control, Per cent.
Lime-sulfur solution	1: 8	88
	1: 9	88
	1:10	88
	1:11	80
	1:12	80—
	1:14	50+

Dry lime-sulfur	72
Sodium sulfur compound	70-72
Barium sulfur compound	60-64

From the above, it is evident that in these tests the liquid lime-sulfur concentrate diluted 1:10 proved equally effective to the 1:8 strength. There was a distinct falling off with the 1:11 and 1:12 strengths, and a sharp decline in killing efficiency at the 1:14 dilution. The dry lime-sulfur and sodium sulfur compound proved about equally effective, but did not give quite as good a kill as the 1:12 dilution of the concentrate. The barium sulfur compound fell considerably below the two others in killing efficiency, and proved but little better than the concentrate at 1:14.

In no case did any of the dry sulfides equal the concentrated lime-sulfur solution, 1:8 or even 1:12, in killing the scale. It is evident, therefore, that the dry materials must be used at strengths higher than those recommended, to bring their killing efficiency up to that of lime-sulfur solution. There are two drawbacks to any such plan:

1. Any material increase in dosage will bring the cost of the dry materials to a very high figure as compared to that of the lime-sulfur solution.

2. There is experimental data to show that the efficiency of the dry materials increases as the dosage grows higher, only up to a certain point. Beyond this, the accumulation of insoluble matter is so great as to offer difficulties in application. Straining out this insoluble matter would doubtless relieve this difficulty, but would require an additional step in the preparation of the spray.

There has been for some time a feeling, which has led to considerable discussion, that equal amounts of the liquid lime-sulfur and of some of the dry sulfides, based on the active principles they contain, are not equal in killing efficiency.

On the basis of the polysulfide sulfur content of each of the materials used in these tests, we find the amount of polysulfide sulfur present in 50 gallons of spray to be as follows:

		Polysulfide sulfur in 50 gallons of spray, lbs.
Lime-sulfur solution	1: 8	15
	1:10	12
	1:12	10.5
	1:14	9
Dry lime-sulfur		6.6
Sodium sulfur compound		5
Barium sulfur compound		3

Comparing these figures with the table above showing the effectiveness of the materials in actual field tests, it is evident that the dry materials had a killing power much nearer that of the lime-sulfur solution than their polysulfide sulfur content would lead one to suppose; and further, that any increased dosage should be figured on the actual performance of the different materials in the field, rather than on a comparison of their chemical content alone.

It is along such a line that further work remains to be done.

From the above tests and the information we now have on these materials, certain conclusions are evident:

1. Under Massachusetts conditions, the commercial lime-sulfur solution,

if thoroughly applied, may be used at a 1:10 dilution and still maintain its high efficiency against scale.

2. At the strengths recommended by their manufacturers, none of the dry products has given as satisfactory control of scale as has the concentrated lime-sulfur solution, even when applied weaker than the usual dilution.

3. The dry materials have shown, in actual field tests, a higher degree of effectiveness as compared with the lime-sulfur solution, than a comparison of their chemical content of polysulfide sulfur would lead us to expect.

4. The dry lime-sulfur and the sodium sulfur compound were about equally effective, and greatly superior to the barium sulfur compound.

5. Great concentration of the dry materials is impractical from the standpoint not only of cost, but also of application, owing to the large amount of insoluble matter accumulating in the tank.

It should be clearly understood that the above statements refer to the concentrated lime-sulfur solution and the dry sulfides purely from the standpoint of their efficiency as dormant sprays for the control of San José scale, and have no bearing on any fungicidal value which the materials may possess.

SOME RESULTS FROM SPRAYING WITH SCALECIDE

BY A. I. BOURNE

For many years the question of oils for spray purposes has held the attention of fruit growers everywhere. Because of their effectiveness against San José scale, oil sprays have been used quite extensively, in spite of the fact that, when not properly prepared, severe injury often followed their use. This condition, at first inimical to the use of these sprays, made comprehensive research studies necessary. These have been organized under the sponsorship of the Crop Protection Institute.

The main lines of endeavor in the investigation as conducted in Massachusetts have fallen into two general classes.

1. A study of both immediate and cumulative effects of Scalecide upon various types of fruit trees common to Massachusetts orchards.

2. A study of the effect of Scalecide upon various insect and other pests, primarily those of orchard trees, and necessarily limited to the species common to this region.

The study of the different phases of plant stimulation or other cumulative effects following the continued use of Scalecide has not yet reached the point where definite conclusions can be drawn. Certain results, however, along the line of the insecticidal value of this material, which our tests have brought out to date, can be briefly reported.

Applied as dormant sprays in the spring against the winter eggs of the European red mite, with results drawn from counts of 20,000 to 25,000 mites of different stages, Scalecide and other materials showed the following relative control values, as compared with unsprayed checks:

Dormoil (a western type oil)	99 per cent
Scalecide	98-99 per cent
Sunoco	97 per cent
Rex oil emulsion	89 per cent
Lubricating oil emulsion 2%	90 per cent

In every test Scalecide has given very nearly perfect control of the overwintering eggs, when applied as a dormant or delayed dormant spray in the spring. One test made with this material applied in the fall gave a degree of control considerably less than that from spring application.

Against the overwintering egg masses of apple tent caterpillars, while not yielding such striking results as noted above, Scalecide has caused a very substantial reduction in hatch. In view of the increasing abundance of this pest throughout Massachusetts during the past few years, this beneficial effect of Scalecide is of considerable significance.

A study of the effect of this spray upon the early spring infestation of apple aphids has not been as comprehensive as might be desired, due to the scarcity of material thus far available. Results to date have indicated a very definite reduction in the numbers of plant lice, from a spring application very nearly approximating the time of hatching of the eggs: *i. e.*, the so-called "delayed dormant" period. Application as a purely dormant spray yielded very slight control of the subsequent hatch.

Spring application of Scalecide on pears yielded a very material check upon the infestation of pear psylla as based on the comparative number of eggs deposited upon unsprayed and sprayed trees. In one season there was found to be a reduction in infestation amounting to over 90 per cent on trees sprayed with Scalecide as compared with unsprayed rows alongside. The following season favorable weather conditions in early spring allowed early activity on the part of the psylla, and some eggs had been deposited before the spray was applied. Subsequent counts of eggs on sprayed blocks indicated a control of better than 85 per cent. Fall applications did not yield any striking control.

Tests made during one spring, using Scalecide diluted 1 to 20 on a small planting of ornamental spruce, against overwintering stages of the spruce gall louse, resulted in very satisfactory control of the insect and no injury to the trees.

Tests with the oyster-shell scale yielded negative results. Except for causing a possible slight delay in appearance of the newly-hatched young, there was very slight effect noted following the sprays. The difference in amount of hatch between unsprayed trees and those given the oil, if any existed, was not enough to be measurable.

In every instance the material was found to possess excellent physical qualities. It "flowed" from the container without difficulty even when the weather was cold, a feature which favorably impresses any grower who has had experience with oils. In preparation for the spray, the material offered no difficulty, mixed readily with the water, and required only moderate agitation. It formed a very stable solution from which there was little or no oil separation, even upon standing for a considerable period.

It should also be noted that, in all of our tests covering three seasons' work with Scalecide applied to several varieties of apple, pear, cherry, plum and peach, covering over two hundred trees, there has been discovered no instance of injury which was in any way attributable to the spray applied.

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AGRICULTURAL EXPERIMENT STATION

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THE CONNECTICUT VALLEY ONION INDUSTRY

PROGRESS REPORTS OF EXPERIMENTAL WORK

This bulletin contains four papers summarizing the experimental work of the Station which is of special value to onion growers. The subjects reported upon are as follows:

Requests for bulletins should be addressed to

AGRICULTURAL EXPERIMENT STATION

AMHERST, MASS.

THE PRESENT STATUS OF THE CONNECTICUT VALLEY ONION INDUSTRY

By LORIAN P. JEFFERSON

Three crops of onions are grown in the United States, early, intermediate and late. The chief competitors of Massachusetts in the production of late onions are New York, Ohio and Indiana. The states of Colorado, Idaho and Minnesota are coming into prominence as onion growing states, but as yet they ship comparatively few onions to eastern markets. Acreage in Massachusetts decreased from 4,560 acres in 1922 to 3,190 in 1924, but in 1925 rose again to 3,820 acres. Production, despite reduced acreage remained about the same, practically 1,250,000 bushels; but the crop of 1925 was reported as 1,580,000 bushels. This indicates either an improvement in cultural methods and in care of the crop at harvest time, or an unusually favorable season.

Owing to recent very unfavorable conditions in California, Ohio and Massachusetts particularly, the total acreage of late onions in the United States was reduced some 14 per cent in 1925. The total of 37,450 acres is the lowest planted for several years.

Onion growers have recently been disturbed by the quantities of foreign onions arriving on our markets. Side by side with home-grown onions the foreign product usually commands a higher price. Inquiry among dealers, however, indicates that these onions are mostly used for different purposes. Of milder flavor, the foreign onions are chiefly used raw in salads and sandwiches.

Boston, the chief market for Connecticut Valley onions, receives large quantities from other sources. During the four seasons, 1921-1924, shipments from Spain and other foreign countries constituted an average of 13 per cent of the receipts in Boston.

The Connecticut Valley supplied 47 per cent, and New York shipped an average of 15 per cent of the receipts. However, a significant feature is the fact that New York shipments increased from 3 per cent in 1921 to 36 per cent in 1924. These arrive in quite regular shipments during the same season as Massachusetts onions.

Freight rates on onions are still favorable to Massachusetts onions on the Boston market, as compared with New York and Mid-Western states. The freight rate on 100 pounds of onions from central points in the Mid-Western onion region to Boston, varies from 55 to 69 cents, while from New York points from which onions are shipped probably 35 to 40 cents per 100 pounds is a fair average rate, onion production being widely distributed throughout the state. The rate from the Connecticut Valley is 20½ cents. If, despite the greater freight charges, growers of the Middle West and New York can compete with local onions on the Boston market, it indicates either lower costs of production or onions of superior quality.

Prices received for the 1924-25 crop were practically the same for New York and Massachusetts onions.

The accompanying tabulation presents figures for acreage and production in Massachusetts, and in three states which are her chief competitors in the production of late onions, with totals for the entire late crop in the United States.

Acreage and Production of Onions in

Massachusetts and Chief Competing States, 1921-1925.

Acreage.

	1921	1922	1923	1924	1925*
Massachusetts	4,500	4,560	3,360	3,190	3,820
New York	7,280	7,740	7,550	7,600	8,640
Ohio	5,080	5,680	5,760	6,240	2,860
Indiana	4,180	5,620	6,300	6,910	4,580
Total late crop in United States	43,560	47,320	46,720	46,580	37,450

Production (Bushels).

	1921	1922	1923	1924	1925*
Massachusetts	1,250,000	1,254,000	1,284,000	1,244,000	1,528,000
New York	2,184,000	2,090,000	3,156,000	3,192,000	3,300,000
Ohio	1,143,000	2,272,000	1,457,000	2,184,000	698,000
Indiana	1,108,000	2,321,000	2,218,000	1,728,000	1,411,000
Total late crop in United States	9,446,000	12,927,000	12,867,000	12,561,000	12,578,000

* Estimates.

FERTILIZERS FOR CONNECTICUT VALLEY ONIONS

By A. B. BEAUMONT and O. E. STREET

Within the last third of a century the Massachusetts Agricultural Experiment Station has conducted a number of experiments with the onion crop. These studies have dealt with problems of soil fertility, use of fertilizers, plant diseases, insect pests and marketing. In this paper, experiments dealing primarily with soil fertility and fertilizers are reviewed.

Field experiments here reported were conducted on the Station grounds at Amherst. The soils on which onions have been grown vary from fine to very fine sandy loam, contain a small to fair amount of organic matter, are slightly to strongly acid, and occur at elevations of 200 to 250 feet above sea level. The field experiments are divided into two groups for discussion. The first or early group extended over the period 1894 to 1917. This is the larger group. The second group was started in 1925 on the lower portion of the new Station farm known as the Brooks Farm. This second group of experiments is presented first.

After a conference with some of the leading onion growers of the Connecticut Valley, constituting an Advisory Committee on onions, field experiments planned to answer the following questions were laid out:

1. Cover crops: Is it practicable to grow cover crops in onion fields of the Valley? If they can be grown have they any value in respect to hastening maturity of the crop and maintaining fertility? What crops can be grown?

2. Lime: How much lime is necessary for best results with onions? Are large amounts injurious?

3. Fertilizers: (a) What is the best ratio of ammonia, phosphoric acid and potash in mixed fertilizers for onions? (b) Is there any advantage in applying fertilizers at different times within the season instead of all at the beginning?

4. Varieties: What varieties of onions are best suited to the Connecticut Valley? Do varieties run true to name? Can desirable varieties be maintained under Valley conditions? What are the best sources of seeds and sets?

Since the experiments have run only one year, and since the attack of mildew coming August 8 practically ruined most of the crop, only progress and incomplete results can be reported. It can be stated:

(1) That timothy, red and crimson clovers can be grown as cover crops in onions, if seeded immediately after the last shove hoeing and not later than July 26. These crops made considerable growth before the ground froze. Biennial sweet clover made poor growth as a cover crop.

(2) Moderate applications of lime, equivalent to one ton ground limestone, gave small increases in yields of onions. Large applications, up to seven tons per acre, showed no additional advantage.

(3) Complete fertilizers rather high in phosphoric acid and fairly high in potash gave the best results. Rate of application was 2500 pounds per acre. That fertilizer having the ratio of 1:3:2 for ammonia, phosphoric acid and potash gave the best yield. The fertilizer had the grade of 4-12-8.

(4) Concentrated complete fertilizers carrying a total of 32 per cent plant food can be used for onions. The 8-16-8 grade was used.

(5) No advantage was gained by the application of fertilizers at different times throughout the growing season instead of all at the beginning.

(6) Source of seed is an important consideration in the selection of seed stock. This was strikingly brought out by the difference in resistance of certain stocks to the attack of the mildew.

In considering this brief report of progress of this second group of field experiments with onions it should be borne in mind that on some points the results are not conclusive but merely indicative. Further, the land on which the plots are located had received very little cultivation for a number of years. It is probable that several years will be required to put it into a condition that is representative of our typical onion land.

The earlier group of field experiments had for their main objective information as to the kind of fertilizer materials required to grow a good onion crop. This objective was the one common to many field experiments conducted throughout the country during the period of early development of agricultural experiment stations. It was not known at the time the experiments started, whether one needed to feed the onion a single or a mixed ration of fertilizers; or which if any one of the plant food nutrients is the most important; whether lime is necessary for onions; etc. Some of these and other questions of plant feeding were answered by the earlier experiments.

The results are summarized as follows:

(1) On Connecticut Valley soils that have been cropped for a number of years, onions cannot be successfully grown unless a complete fertilizer, or one carrying ammonia, phosphoric acid and potash, at least, is used. There is still unanswered the question as to the necessity of sulfur, but since it is ordinarily present in a complete fertilizer the question is not at present very important.

(2) Fertilizers carrying ammonia entirely in the form of certain chemicals were found to be as good as those carrying ammonia in organic form

only. The significance of this fact may, however, be questioned, and for two reasons: (a) as used, neither treatment produced a large crop; and (b) the usual practice of combining organic with inorganic nitrogen was not included in the experiment.

(3) Nitrate of soda proved to be better than sulfate of ammonia as a carrier of ammonia when there was a deficiency of lime in the soil. Most of our Valley soils are deficient in lime. If lime is supplied in sufficient amounts, ammonium sulfate is as good as nitrate of soda for onions.

(4) Moderate applications of lime in practically all cases were matched by increased yields of onions. This response to lime was particularly marked when ammonium sulfate and muriate of potash were used in combination. Moderate applications (1 to 2 tons) to onions lose most of their effect within four years.

(5) There is little choice between muriate and sulfate of potash as carriers of potash for onions unless there is a great deficiency of lime, when the sulfate is preferable.

(6) Onions have responded well to fertilizers carrying a large proportion of soluble phosphates. A high proportion of phosphoric acid reduces but does not do away with the need of lime.

(7) From the standpoint of fertility, onions can be grown successfully with large (30 tons) applications of manure. Fertilizers used in addition to the manure have no additional advantage.

There are three conclusions common to the groups of experiments worthy of emphasis.

1. For continuous growth of onions on Connecticut Valley soils a complete fertilizer is necessary.

2. Complete fertilizers having a high ratio of phosphoric acid give best results with onions.

3. Moderate and frequent applications of lime are necessary for onions on Valley soils.

There appears to be little if any necessity of a choice of carriers for ammonia, phosphoric acid or potash provided practice is in accordance with these three conclusions.

ONION BLIGHT or DOWNY MILDEW

By A. VINCENT OSMUN

This disease caused widespread damage to the onion crop of the Connecticut Valley in 1924 and 1925. The first authentic report of its occurrence in Massachusetts was in late August, 1924. It is probable, however, that it has been present within the state for a much longer period, as it was reported many years ago from Connecticut, Vermont and New York. Our growers have indeed long been familiar with a disease known to them as "blight," the symptoms of which appear not to be different from those of the disease here under discussion. The disease was first reported in this country from Wisconsin in 1884.

Onion blight is caused by a parasitic fungus known technically as *Peronospora schleideni*. This is one of a group of fungi called Downy Mildews, and hence the name Downy Mildew is often used to designate the disease as well as the fungus which causes it.

Downy mildew attacks the onion tops, starting with a few onions in different parts of a field, and spreading from these centers of infection. In its early stages, even before the tissues are killed by its attack, the mildew may be detected in early morning when the leaves are wet with dew, or during a rain, as small violet colored patches. In the sun these patches dry out and collapse, leaving yellowish or white spots. The mildew quickly spreads over the entire leaf which becomes water-soaked in appearance, collapses and breaks over. The shriveled leaves are soon blackened by mold. Usually, new leaves develop following the first attack, and if weather conditions continue to favor development of the disease, these may also succumb. However, even with the new crop of leaves the bulb seldom attains full size, and the crop is thus reduced.

Downy mildews characteristically thrive best under moist, cool conditions, and downy mildew of onion is no exception. Periods of rain or high humidity with low night temperatures occurring between early July and late September are likely to bring on the disease, and at such times the fields should be closely watched for the first symptoms. With weather conditions favoring the disease its spread is very rapid, often considerable areas becoming affected within a few days and leaves dying within a short time after infection. It was not uncommon last season to find entire fields laid low by the disease.

Control measures for onion blight have been worked out. The various phases of control are based on (1) the ability of the mildew to live over winter in old onion refuse, (2) influence of environmental conditions and (3) susceptibility of the fungus to toxic fungicides.

(1) In order to reduce the possibilities of infection from previous diseased crops, onion refuse should be burned. A three or four year crop rotation also may be helpful in this connection.

(2) As excessive moisture favors development of the mildew, every practicable means should be taken to promote the drying off of the onion tops following periods of high humidity. Under-drainage, clean culture, exposure to prevailing winds, all help in drying off a wet field.

(3) Spraying with 4-4-50 Bordeaux mixture with three pounds of resin fish-oil soap added as a sticker is effective if the applications are sufficiently prompt, thorough, and frequent. If spraying is to be the program, the weather conditions should be closely watched, as the first application must anticipate appearance of the mildew. All tops must be thoroughly covered by the fungicide, and spraying should be repeated at least once a week or every three or four days if weather conditions favoring spread of the disease are prolonged.

Onion growers are not equipped with adequate spraying machinery, if indeed such machinery is in existence. Yet there can be no doubt that downy mildew will continue to attack the onion whenever moisture and temperature conditions suited to its development occur. Growers must face this possibility each season and must decide for themselves whether it will be more profitable to take the loss from possible reduction of yield, or apply the control measures above outlined.

A STUDY OF THE LIFE HISTORY AND CONTROL OF THE ONION THRIPS

By A. I. BOURNE

The onion thrips is, without question, the outstanding insect pest of the onion. In cases of severe outbreaks, the losses it has caused have often been rated as high as 25 to 50 per cent of the crop. The injury, variously termed *blast, white blight,* and *silver top,* results from these minute insects extracting the plant fluids, by means of their rasping and sucking mouth parts.

Throughout the Connecticut Valley, the main onion growing section of Massachusetts, this pest has, during late years, become very generally established and appears in large numbers annually. Previously, its ravages were chiefly confined to occasional outbreaks, many times of only local importance. With the increased acreage devoted to set onions, the thrips has come to be an annually recurring pest, and gives every evidence of increasing abundance.

Relation of Set Onions to Thrips Injury

The very close correlation of the set onion industry to the problem of thrips injury to onions grown from seed is generally recognized. Set onions on the average develop several weeks earlier than the crop of seed onions. Sets, therefore, serve as ideal nurseries for the colonization and multiplication of the thrips. The insects are thus supplied with an abundance of their favorite food plant, and consequently are able to reach large numbers comparatively early in the season. From actual counts made in the field, of the thrips colonized on nearly mature plants of set onions, it was found that two to three hundred thrips per plant were about an average, while five to six hundred were by no means uncommon. The sets themselves do not as a rule suffer severely from the attack of the thrips, since, by the time the insects have developed a heavy infestation, the plants have advanced well toward maturity and accumulated enough leaf surface to withstand the attack.

Areas given over to sets are often located close to, or even alongside, fields later planted to seed onions, so that transfer over onto the younger and smaller plants is easy. This practically assures the later development of a heavy infestation in the fields of seed onions. Observations have shown that while there is more or less of a spread from the sets before they are mature, the great movement takes place when the sets are ready to be pulled. From our studies of the life history of the insect, it was learned that the time of this general transfer usually coincides very closely with the period of greatest reproductive activity of the insect, thus increasing the danger to the fields of seed onions.

There are other sources of possible infestation—refuse and screenings, weeds, grasses, etc. The list of plants upon which the thrips has been found to feed includes many garden and field crops, ornamentals, and greenhouse plants as well as various grasses. While these are of comparatively little importance as compared with set onions, they do offer the insect ample opportunity for hibernation and early spring colonization, and explain why onion fields are often invaded from grass or weedy borders. For this reason, it is recommended to burn over, in late fall or early spring, grass and weedy areas bordering on onion fields.

Dusting for Control of Thrips

In the Experiment Station study on thrips control, various types of commercial nicotine dusts, as well as home prepared dusts, were tested. A study was made of the comparative efficiency of different strengths of nicotine in the dusts; and of the form in which the active principle was present (free nicotine or nicotine sulfate). The influence of weather conditions on the effectivness of the dusts was also studied, to determine the best time to make the applications. Different methods of applying the dusts were tried out, as well as the use of auxiliaries (hoods, curtains, etc.) to confine the dust discharged, prevent drift and so counteract the interference caused by wind.

Nicotine dusts, even those carrying a comparatively small percentage of nicotine, readily kill all the insects reached and are effective early in the season. By applying the nicotine dusts at intervals of about ten days, beginning with the first appearance of the thrips, the insects are held down sufficiently so that the plants can withstand a moderate infestation. The cost of such a practice, however, is almost prohibitive. Later in the season, the nicotine dusts are not satisfactory, since they cannot penetrate the tight crevices in the axils of the inner leaves, where a very large percentage of the thrips congregate.

Study was also made of the recently introduced calcium cyanide dusts. These possess excellent physical qualities, and the gas given off penetrates the tight crevices in the axils of the inner leaves very successfully, overcoming the thrips in practically every portion of the plant. The gas is soon dissipated, however, and a very large percentage of the thrips recover from its effects and resume normal activity. At present the cost of these dusts is high. These difficulties do not appear to be insurmountable. If the manufacturers make as rapid progress in the development of these dusts in the near future as they have in the last two years, calcium cyanide gives promise of becoming a very satisfactory control.

Spraying for Control of Thrips

In a study of the possibilities of sprays for the control of this pest, tests were made of a long list of materials, including almost every type of contact spray. Preliminary tests eliminated very many of these as ineffective or impracticable from one cause or another, and the field soon narrowed down to include the nicotine-soap combinations and certain oil sprays.

One of the greatest problems in thrips control is to reach and kill the insects deep down in the axils of the leaves (chits), where they congregate in large numbers. On account of the peculiar nature of the plant and the smooth, waxy surface of the leaves, any spray to be successful must possess excellent adhesive and spreading properties, as well as insecticidal value. Oil sprays, while very effective against all thrips actually touched, showed a very strong tendency to form into drops and roll off the plants without thoroughly covering all the leaf surface, thus forming "islands" where thrips were untouched by the spray and so escaped. Nicotine sprays used alone do not have the necessary physical qualities. When they are combined with soaps, however, they constitute a spray which possesses all of these qualifications to a very high degree.

Lack of machinery has stood in the way of successful use of sprays. The ordinary types of horse-drawn sprayers cannot be used in onion fields. The common nozzles, delivering a cone spray, have not succeeded in forcing the spray deep down into the narrow space at the base of the inner leaves. The problem was, therefore, to develop a method of driving the liquid well in among the close-standing plants and force it down into the axils of the leaves; also, to find a spray of superior wetting and flowing qualities that is toxic to all stages of the insect and has a killing action rapid enough to overcome the active winged adults.

Nicotine sulfate, the commercial 40 per cent solution, coupled with fish-oil soap, was found to answer the requirements of a spray. A small Skinner System irrigation nozzle, modified to deliver the spray at the desired angle and distribute the pressure evenly, has given good results. This delivers a thin, flat, fan-shaped spray which, with moderate pressure, is broken up into a very fine mist. The full force of the discharge is confined to a comparatively small space, so that the spray may be directed upon the portion of the plant desired, with full advantage of the amount of pressure, and with little waste of material.

This flat spray, directed upon the plants from the side, caused a vibration of the young, limber leaves which, in conjunction with the excellent wetting and flowing qualities of the spray, allowed it to work down into the tight chits and reach the thrips congregated there. From our experiments to date, a steady pressure of 125 to 150 pounds has proven satisfactory, giving a very fine mist and allowing good penetration.

The most satisfactory spray formula used was as follows:
Nicotine sulfate ("Black Leaf 40," Nicotine Sulfate 40 per cent", etc.), ½ pint to 100 gallons (1:1500), Good's No. 3 Potash Fish-oil Soap, 6-8 pounds per 100 gallons of spray.

The soap used in this formula is soft and "pourable", very easily handled and mixed into the spray. This product is of such uniform consistency that proper dilution can be made by measuring the soap as it is drawn from the container, thus allowing a saving of time when refilling the spray tank in the field. The spray made on the above formula had excellent spreading and "flowing" qualities, and covered the smooth, waxy surface of the onion tops very readily. The most promising feature was its tendency to flow down to the base of the stems and into the tight crevices, allowing the nicotine to reach and kill the colonies of thrips clustered there. In addition, the alkali of the soap served as an activator of the nicotine, thus hastening its insecticidal action.

In field tests at North Sunderland, this spray was applied to a section of a large field of onions which had become heavily infested from sets growing alongside. When the sets had been screened and disposed of, this section of the field was sprayed, using a power outfit delivering a steady pressure of 125-150 pounds, with two lines of hose operating. Owing to the heavy, driving rains and the *mildew* which had appeared in the field, some of the plants were broken down, making it difficult to make a thorough application.

Examination of the field the day following the application showed the following:

	Thrips per 100 plants	Average per plant	Control Per cent
Sprayed	165	1- 2	97+
Unsprayed	5230	52-53	—

Despite the very high percentage of control obtained, a second application has been found to be advisable, for restocking takes place very rapidly through the hatching of eggs inserted in the leaf tissues. This second spray should be applied after all the eggs have hatched, and before the first appearing larvae have matured and left the plants. Because the nicotine soap spray cuts down very materially larvae hatching for a period of at least two days after application, the period between the sprays may safely be extended to seven or eight days.

The Critical Period in Thrips Infestation

The data from field observations and life history studies revealed the fact that reproductive activity and consequently the rate of increase vary considerably during the season.

Infestation is comparatively light and shows no marked increase up to about mid-July. From that point there is a steady increase through that month, with a sudden rise to the climax of the season about the first of August. Beyond that point there is a gradual slowing up of reproductive activity for the remainder of the season.

The critical period as regards thrips infestation, therefore, occurs during late July and early August. At this time the insects have transferred in large numbers from sets and are rapidly developing an infestation on the fields of seed onions. This source of danger, coming as it does at the time of greatest reproductive activity on the part of the insect, makes this point in the season a very serious one for seed onions, and emphasizes the need of the follow-up spray to check the pest as thoroughly as possible and give greatest protection to the plants at this particular period.

Conclusion

Our studies to date have shown that the chief source of thrips infestation of seed onions is from nearby fields of set onions, and that the greatest movement of thrips takes place at the time the sets mature and are pulled. This coincides with the period of greatest reproductive activity on the part of the thrips, and comes in late July and early August.

Both from the standpoint of cost and of effectiveness, dusts do not give satisfactory control. This is true both of the nicotine dusts and of the newer calcium cyanide dusts, although the latter show considerable promise.

The usual type of spray nozzles proved unsatisfactory for this purpose, and a nozzle delivering a flat spray has been developed. This delivers the spray where it is needed, and, with a pressure of 125-150 pounds causes it to penetrate the axils of the leaves where the greatest number of thrips congregate.

Nicotine sulfate, 1-1500, with Good's No. 3 Potash Fish-oil Soap added at the rate of 3-4 pounds per 50 gallons of spray was found to give satisfactory control. A second spray application, seven to eight days after the first, has been found advisable to take care of the larvae hatched from eggs laid in the tissues of the plant.

The usual types of spray machinery are not well adapted to operate in large fields of onions. The development or adapation of an outfit which will conform to the particular requirements for the spraying of onions presents the most immediate problem.

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MASSACHUSETTS

AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 228 MARCH, 1926

AN ECONOMIC STUDY OF THE MASSACHUSETTS APPLE INDUSTRY

By HUBERT W. YOUNT and LORIAN P. JEFFERSON

According to the data reported in this bulletin, the task of marketing the Massachusetts apple crop ten years from now may be nearly double what it is today. Existing plantings, with no allowance for new plantings, indicate an increase in the apple crop, in the next ten years, ranging from 240 per cent for McIntosh down to 13 per cent for Wealthy. Were this increase to come suddenly, or without preparation on the part of growers' organizations, it might be impossible to market the crop to advantage. With knowledge as to the probable size of coming crops, growers will have not only a guide to new planting, but opportunity to develop new markets. It was for the purpose of attaining this dual objective, that the work reported in this bulletin was undertaken.

Requests for bulletins should be addressed to
AGRICULTURAL EXPERIMENT STATION
AMHERST, MASS.

AN ECONOMIC STUDY OF THE MASSACHUSETTS APPLE INDUSTRY

By HUBERT W. YOUNT and LORIAN P. JEFFERSON

Introduction

The apple growers of Massachusetts, in common with those of the other New England States, have felt for some time the need of more definite knowledge of the apple industry—the number and ages of trees of different varieties, and the volume of the commercial crop. In order to obtain this information it was determined by a group representing the Experiment Stations, State Departments of Agriculture, the New England Research Council, the Federal Bureau of Agricultural Economics and the New England Crop Reporting Service, that a study should be made of the apple industry of New England. The purposes of this study were, specifically:

1. To secure information as to number and age of trees and the trend of planting.
2. To discover the volume of the apple crop and the amounts put on the market.
3. To discover the relative importance of each commercial variety.
4. To determine the relative importance of orchards of different size.
5. To discover common orchard practices in different producing areas.
6. To learn the relative importance of apple growing as a source of farm income.
7. To determine the relative importance of different methods of marketing.
8. To discover the extent to which grading is done.
9. To learn the prices received and the reasons for price differences.
10. To determine available farm storage space and the quantities stored.
11. To determine probable future production.

Methods and Scope

The method employed in Massachusetts was personal interview with each owner of a commercial orchard. For the purposes of this study a commercial orchard was defined as one which contained a minimum of 100 bearing trees. Exceptions were made in cases where orchards of fewer than 100 bearing trees were of evident commercial importance, or where there were considerable plantings of young trees which gave evidence of future commercial importance.

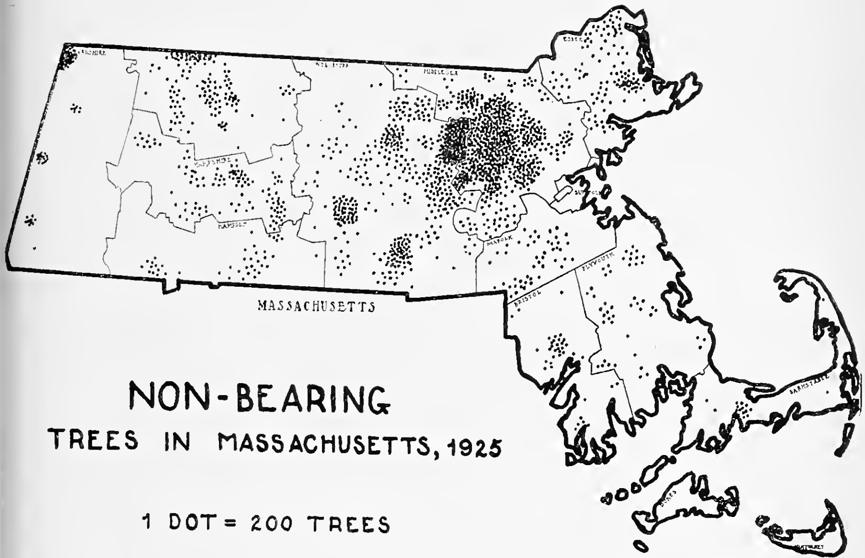
Visits were made to over 2,000 apple growers and complete schedules were secured from 1,754, which is 7 per cent of the whole number who reported apple trees in the Census of 1925. The growers visited reported 45 per cent of the trees and 55 per cent of the production as stated in the Federal Census of 1925. However, a large part of the production reported to the Federal Census is used on the farm or sold for making into cider, and it is estimated that the farms included in this survey grow over 75 per cent of the marketable apples of the state.

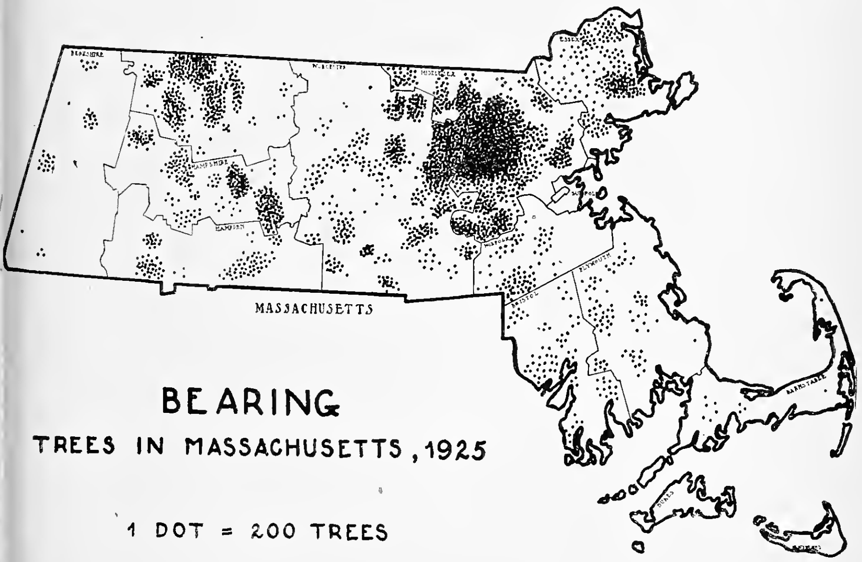
Cooperating Agencies

Cooperating with the Department of Agricultural Economics of the Massachusetts Experiment Station in securing this information, was the State

Department of Agriculture which contributed the salary and expenses of two investigators for field work. The New England Research Council acted as a coordinating agency, in order to insure the collection of uniform data throughout the New England states.

CHART 1. Non-bearing and Bearing Trees, 1925





Producing Regions

Apple growing in Massachusetts centers in several rather distinct sections, although apples are grown for home consumption in every part of the state. These are Franklin County, Connecticut Valley, Nashoba area and Essex County.

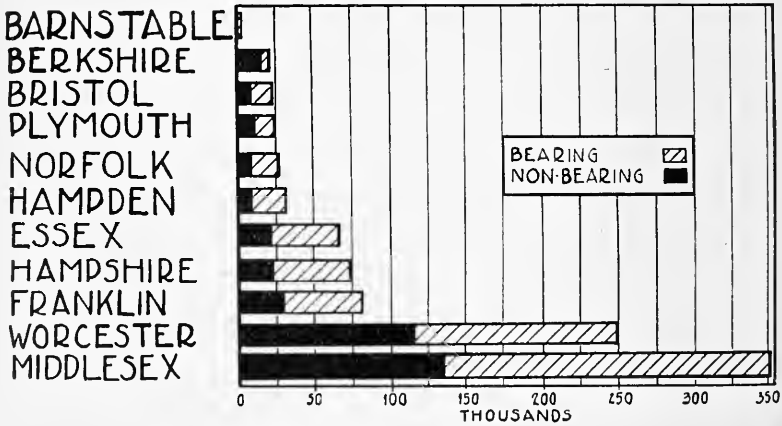
The chief section, lying partly in Middlesex and partly in Worcester counties and known as the Nashoba area, includes the towns of Littleton, Acton, Groton, Harvard, Stow, Sterling, Hudson, Boxborough, Bolton and Westford. Other towns which form a southern continuation of this area are Berlin, Marlborough, Northborough, Westborough and Millbury. Shirley, Lunenburg and Fitchburg form a similar group to the northwest. The topography of this section differs from that in other apple sections of the state, varying from fairly level to very rolling. The outstanding characteristics of this section are numerous small orchards and high production due to good orchard practice.

The Franklin County section, in the western part of the state, is included chiefly in the towns of Colrain, Shelburne, Buckland, Charlemont and Ashfield. Few growers here make apple growing their chief business, as orchards are mostly secondary to other farm enterprises. The varieties commonly grown are Baldwin and McIntosh, with a few Greening and Duchess. This region is hilly, almost mountainous in parts. Most of the orchards are irregular plantings on hillsides, trees being set in blocks in but few orchards.

Similar in many respects is the section in Essex County in the northeastern part of the state. Varieties grown here are chiefly Baldwin, with some McIntosh and small numbers of other kinds. In both Essex and Franklin counties most of the orchards are old and production is declining except in a few towns. It is doubtful if recent plantings in either of these sections have been sufficient to offset the dying of old trees.

The section in Hampden and Hampshire counties is composed of several separate areas lying on the hills along the Connecticut Valley. The towns of Cummington, Williamsburg, Easthampton and Granville form that portion lying west of the Connecticut River, while Amherst, Belchertown, Hampden and Wilbraham are included in the section east of the river.

CHART 2. Non-bearing and Bearing Trees, by Counties, 1925



In the southeastern part of the state are scattered areas consisting of a few specialized towns in Plymouth and Bristol counties. Orchards throughout this section vary greatly as to size, care and varieties. The orchards are, moreover, much scattered, some towns having none, while others grow large quantities of apples in orchards of considerable size.

Number and Age of Trees

A total of nearly a million trees was reported, one-third being not yet in bearing. Forty per cent of the trees are in Middlesex County, which with Franklin and Worcester counties produces about three-fourths of the total crop reported. The ratio of bearing and non-bearing trees varies in different sections. Only 24 per cent of the trees of Franklin County were reported as non-bearing, while in Worcester County 45 per cent are not yet in bearing. The other important counties fall between these extremes.

The estimated average age of trees reported in Massachusetts is seventeen years. There are thousands of trees from thirty to fifty or more years of age, but the great number of trees recently planted reduces the average to this low figure. According to the reports of the growers, about two-thirds of the trees are under fifteen years of age. The following table brings out the pertinent facts concerning age of trees in 1925.

Table 1. Age of Trees in Massachusetts, 1925

Age	Number of Trees	Per cent of Total	Cumulative Per cent
Under 5 years	202,077	20.5	20.5
5 - 9 years	259,804	26.4	46.9
10 - 14 years	188,980	19.2	66.1
15 - 19 years	64,966	6.6	72.7
20 - 29 years	56,382	5.7	78.4
Over 30 years	133,237	13.5	91.9
Unclassified*	79,118	8.1	100.0
Total	984,564	100.0	100.0

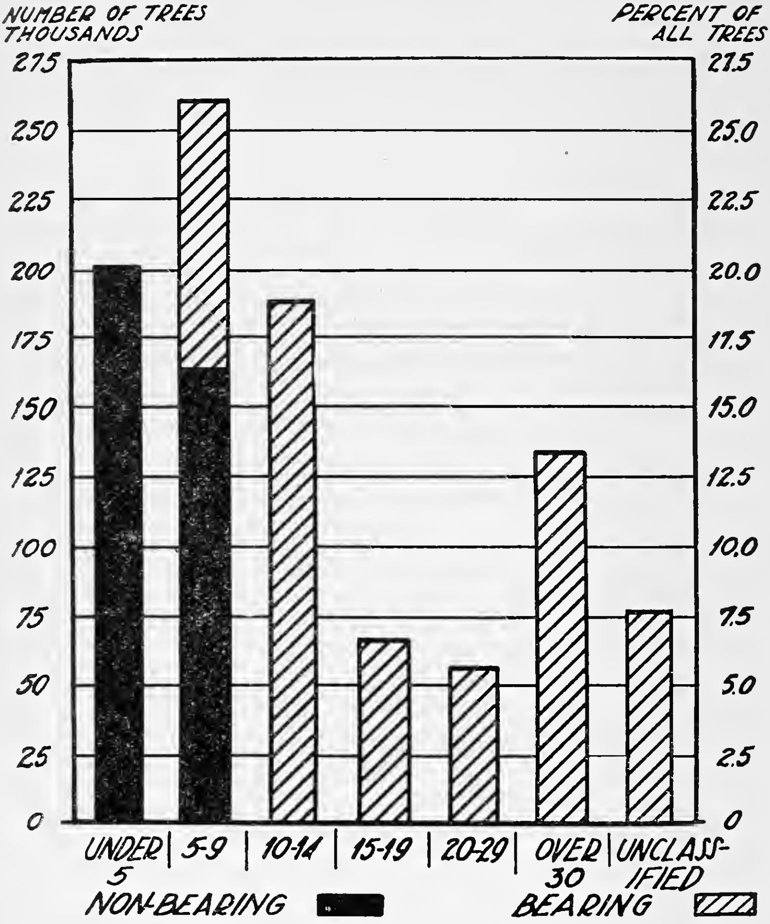
* "Unclassified" means that the age of the trees was not known. Most of these, however, were old trees.

The period of heaviest plantings was between 1915 and 1920. Although there has been a decline of 20 per cent from this high period, new plantings are still being made at the rate of 30,000 to 40,000 trees each year.

Fillers

The number of fillers reported was only 74,000 trees, or about 7 per cent of the total. These were divided equally between bearing and non-bearing, as most of the varieties used for fillers bear at an early age. Fillers are usually cut between the twelfth and fifteenth years, and 95 per cent of those reported are under fifteen years of age. The age grouping is fairly uniform, so that approximately 5,000 trees will be cut each year for the next fifteen years. Several varieties are used as fillers, but about half of those now planted are Wealthy. The McIntosh ranks second in importance, but it is probable that few of the McIntosh fillers will be removed, since already Baldwin and Delicious planted as permanents are being cut instead of McIn-

CHART 3. Age of Trees, 1925



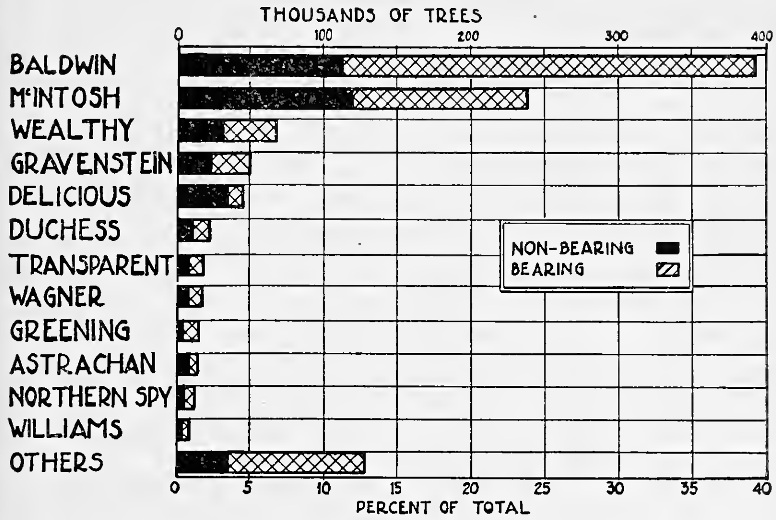
tosh. The Duchess, Wagener and Transparent are all used extensively as fillers and are of about equal importance. Growers expressed considerable dissatisfaction with the filler system and it is not being used on many of the new plantings.

Many growers were unable to state the exact number of fillers, but it is estimated that the figures given are about 75 per cent correct, which would bring the total number of fillers to approximately 100,000 trees.

Principal Varieties

Over 100 varieties were reported by the growers visited, the number of each variety varying from one to several thousand. The number of varieties for which there is a definite market is limited, and there is a strong tendency on the part of the larger growers to limit production to four or five standard varieties. Most of the minor varieties have been planted in small orchards

CHART 4. Non-bearing and Bearing Trees of Leading Varieties, 1925.



for family use or by a few large growers catering to a roadside or other specialized trade.

Baldwin

The Baldwin is the most important commercial variety in Massachusetts, making up 40 per cent of all trees reported. It is found in nine-tenths of the orchards and its continued popularity is indicated by the fact that nearly half of the growers have young trees. Of nearly 400,000 Baldwin trees, over 25 per cent are not yet bearing. The average age, nearly twenty-five years, is

CHART 5. Recent Plantings of Leading Varieties, by Five-Year Periods.

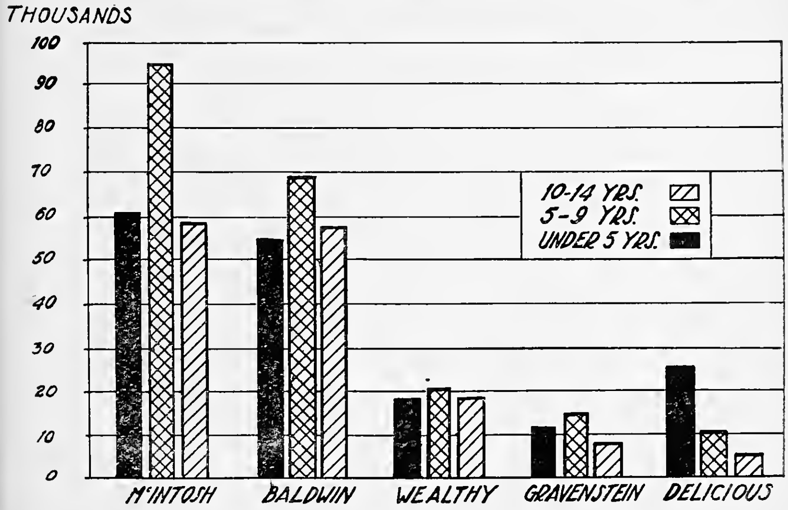
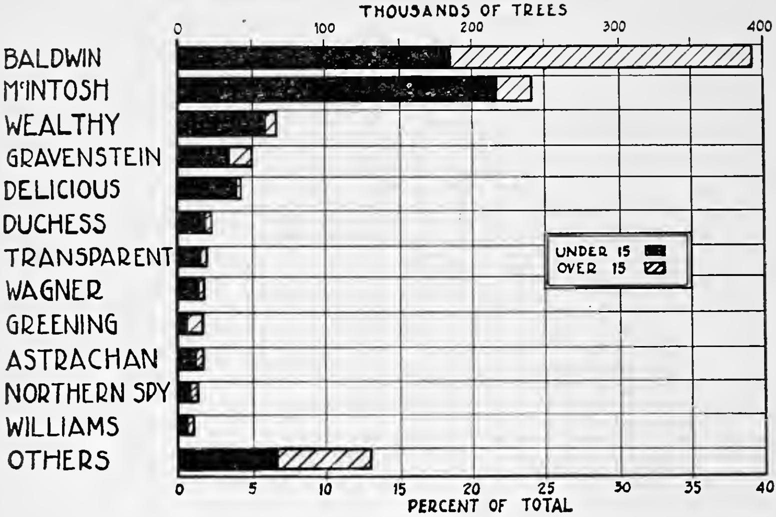


CHART 6. Trees Under and Over Fifteen Years of Age, for Principal Varieties.



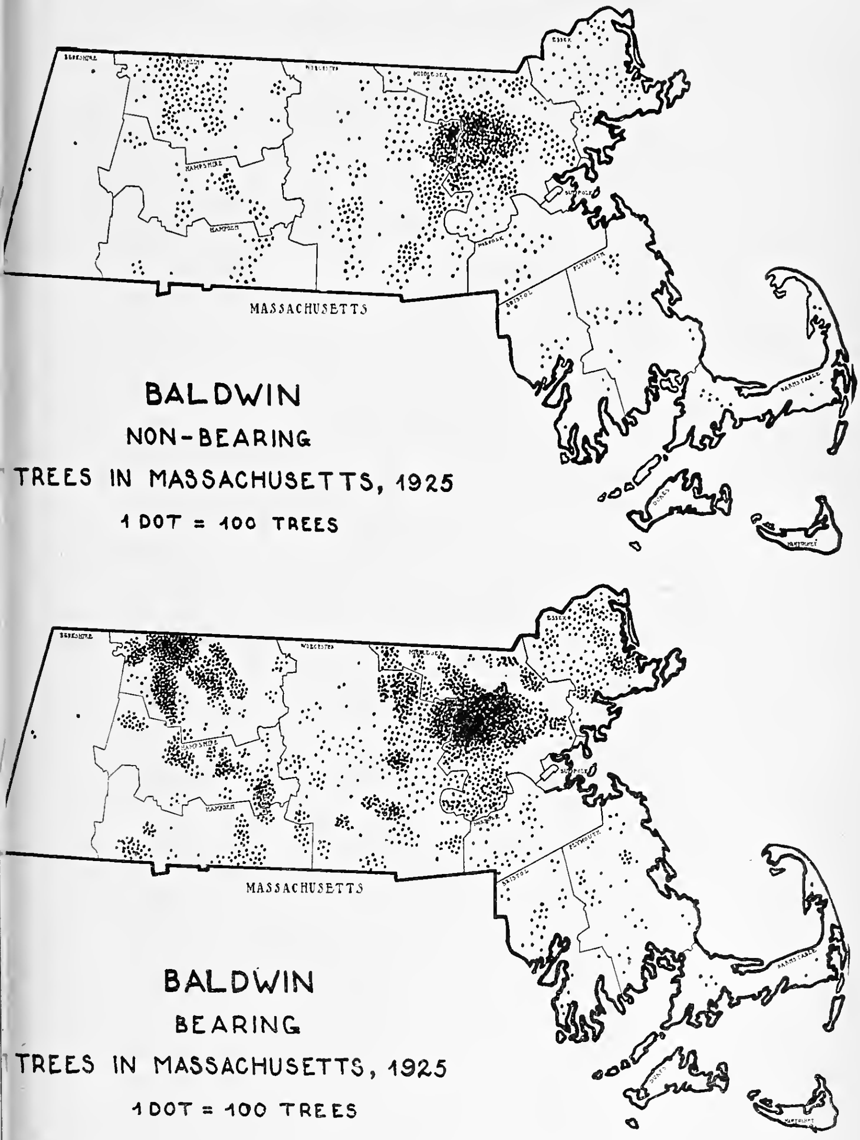
relatively high, one-fourth being over thirty years old. A number of these old trees go out of production each year, but the recent plantings make up for this reduction. Baldwin plantings during the past fifteen years have been almost as heavy as those of McIntosh. Over 50,000 trees have been set during the past five years, and the plantings for the five-year period previous to 1920 were considerably above this figure. Nearly half of the Baldwin trees are under fifteen years of age, and allowing for the loss of old trees, it is reasonable to expect a 50 per cent increase in the crop during the next fifteen years. The popularity of the McIntosh will undoubtedly reduce future plantings of Baldwins. The Baldwin crop in 1924 was over 50 per cent of the entire crop of the State.

McIntosh

The McIntosh is the second most important variety grown in the State. Nearly 25 per cent of all trees are of this variety and the percentage is increasing each year. Of the 240,000 McIntosh trees reported, about half are not yet in bearing. Over 90 per cent of the McIntosh have been planted during the past fifteen years, which means that only a small number of the trees now bearing have reached full production. The heaviest planting occurred from 1915 to 1920, an average of 18,000 trees being planted per year. The present annual rate of 10,000 trees indicates a 40 per cent decline from that period. The average age of the bearing McIntosh was twelve years in 1925. As these trees mature in the next ten or fifteen years their production will be greatly increased. In addition, about 120,000 young trees will come into full bearing during this period. This estimate includes no new plantings and allows for a loss of 25 per cent of the present young trees. The production of McIntosh in 1924 was slightly over 200,000 bushels, about one-seventh of the total commercial crop. Since the 1924 season was a poor one for McIntosh, this figure is below the average crop.

More grading is done on the McIntosh than on any other variety, approx-

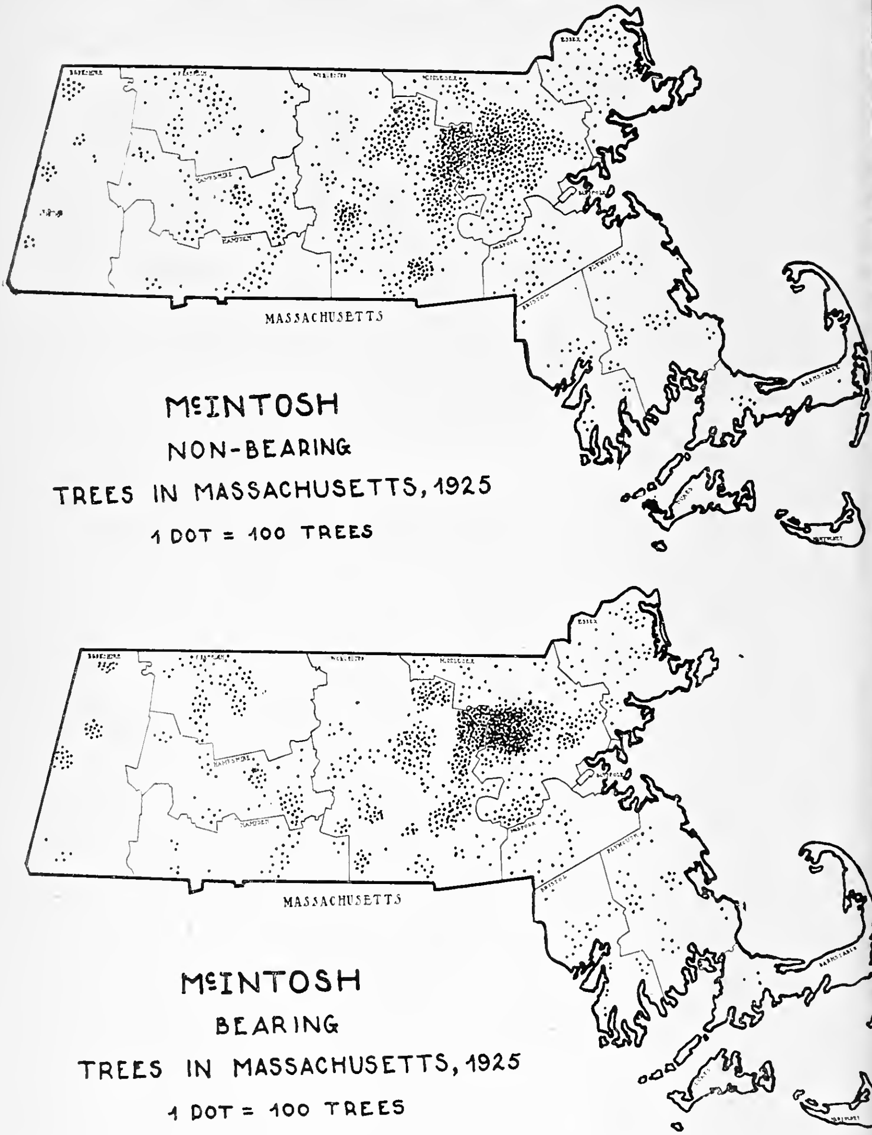
CHART 7. Non-bearing and Bearing Baldwin Trees, 1925.



imately half of the 1924 crop being graded. Of this amount, 15 per cent were sold as Fancy. About two-thirds were A's and the remainder B's, many growers reporting as much as 75 per cent of their crop as A grade or Fancy. Prices received for McIntosh averaged almost double those for Baldwin, varying with the section of the state, the amount of grading and the care taken in production.

Ten thousand McIntosh trees were reported as fillers, divided equally be-

CHART 8. Non-bearing and Bearing McIntosh Trees, 1925.



tween bearing and non-bearing. It is probable, as stated above, that many growers who reported McIntosh fillers will not cut them.

Wealthy

The Wealthy is the most important of the minor commercial varieties. Since the Baldwin and McIntosh together make up over two-thirds of the total number of trees, no other single variety appears important when compared with them. There are over 60,000 Wealthy trees in the state, of which nearly half are not yet bearing. The Wealthy is planted primarily as a filler, and nearly 60 per cent of the present number are used for that purpose. Over 80 per cent of the Wealthy plantings are under fifteen years of age, and the production of this variety may be expected to decline very little, even with the removal of fillers. Plantings during each of the five-year periods since 1910 have been about equal and the indications are that the present rate of 3,000 trees per year will continue. Wealthy production amounts to only 5 per cent of the total. About 40 per cent of the Wealthies sold are graded, and 75 per cent of those graded were sold as A's. Disease and insect damage made some difference in this figure during the past season.

Gravenstein

The Gravenstein crop is much larger than the Wealthy crop, although there are fewer trees. Out of nearly 50,000 trees reported, 40 per cent are not yet bearing. The Gravenstein has a higher percentage of non-bearing trees than any other variety except the McIntosh. Plantings during the past five years total over 11,000 trees, a decline of 35 per cent from the preceding five-year period. Two-thirds of the Gravenstein trees are under fifteen years of age, which indicates a substantial increase in production in the future. The total production in 1924 of 115,000 bushels, an average of four bushels per tree, was almost double the Wealthy crop. Two-thirds of the crop was sold ungraded, but of the amount graded, nearly 80 per cent was A grade.

Delicious

The Delicious is a comparative newcomer in Massachusetts, and of the 42,000 trees reported, over three-fourths are not yet bearing. Recent plantings have been very heavy; over 60 per cent of all trees of this variety have been set since 1920. One-fourth of the reporting growers have Delicious trees, usually in small blocks for experimental purposes.

Growers of this variety report sales difficult for the lower grades, but the total volume of production is not sufficient to be a real factor on the market.

Duchess

The Duchess is the favorite of the early varieties, although there are only 20,000 trees, about half of which are not bearing. This variety is principally planted as a filler, 40 per cent of the trees reported being for that purpose. Plantings have fallen off during the past five years, and the present rate of 1,000 per year seems likely to decrease. Most of the Duchess trees are under fifteen years of age, since they are early bearing and short lived. Coming on the market early, production is not an important factor in the general market, except for competition with early Wealthies.

Transparent

The Transparent is another of the early varieties used as a filler. Of the 16,000 Transparent trees reported, three-fourths are bearing. The rate of planting has decreased recently, and many growers express the intention of cutting out these trees. The poor quality of the fruit, its susceptibility to insect injury and small size are some of the reasons advanced for discontinuing the variety.

Wagener

This variety has recently come into favor, particularly in large orchards. Eighty growers reported a total of 15,000 trees in 1925, 60 per cent of which were already bearing. About 50 per cent of the plantings are fillers. Most of the planting has been done during the past ten years, very few trees being more than fifteen years of age. The favor with which this variety is being received by the growers indicates that it will be of more importance in the future.

Greening

The Rhode Island Greening, one of the oldest Massachusetts varieties, is fast passing out. A total of 14,000 trees was reported, of which only 2,000 were non-bearing. Since most of the bearing trees are old, production per tree is high and a total of 26,000 bushels was reported. The poor market for this variety has caused many growers to cut down their trees. The variety is of little commercial importance except in certain sections of the western part of the State.

Astrachan

This variety, formerly a favorite in the farm orchard, is now of little commercial importance. Nearly half of the 13,000 trees reported are non-bearing, and new trees are planted at the rate of nearly 3,000 for each five-year period. The crop is about equal to that of Transparent or Duchess, and comes on the market at about the same time.

Northern Spy

Only 1 per cent of the total number of trees reported were Northern Spy, and plantings are growing less. One-third of the 10,000 trees reported were not bearing, and 70 per cent of the trees are not fifteen years of age. Late bearing and poor market demand account for the lack of popularity of Northern Spy among growers.

Williams

This is one of the older early varieties and is popular in a few sections of the state. Only 7,000 trees were reported, and of this number 2,000 were non-bearing. Recent plantings of over 1,000 trees for each five-year period indicate some increase, which will probably be offset by the cutting of old trees. The production of 17,000 bushels compares favorably with the other early varieties, but is not of sufficient importance to become a factor in the market.

Miscellaneous Varieties

Many other varieties were reported, among them Hubbardston, Wolf River, Grimes Golden, Tolman Sweet, Pippin, etc., none of which is of commercial importance.

Size of Bearing Orchard

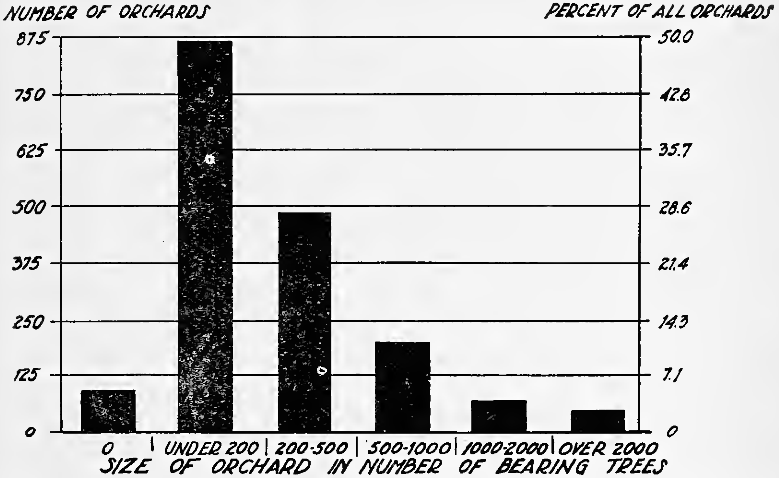
The size of the producing orchard, measured in bearing trees, varies from a few trees to as many as 12,000. The average for all the growers visited is 354 bearing trees. Over half report fewer than 200 bearing trees and the most common size is about 150 trees.

The size of orchard varies with the section of the state. Hampshire County has the highest average with 510 bearing trees. This does not mean that most of the orchards are larger than in other sections, but that there are more large orchards. The most common size is the same for all counties, from 100 to 199 trees. Worcester County ranks second in size with an average of 411 trees, while Hampden County, with 192, is low. Norfolk, Bristol and Plymouth average under 300 trees, indicating few large orchards in those sections.

Ninety-five growers had no bearing trees, but reported young orchards containing nearly one-fourth of the total number of non-bearing trees. This group, comprising only 5 per cent of the growers, averages over 900 young trees per orchard and includes some of the largest single plantings in the state.

Nearly one-fifth of the growers visited own bearing orchards of less than 100 trees. This group of orchards represents blocks of young plantings or old orchards that are well-cared for and commercially important in their section. Many of these growers have maintained a relatively profitable farm orchard

CHART 9. Size of Bearing Orchards, 1925.

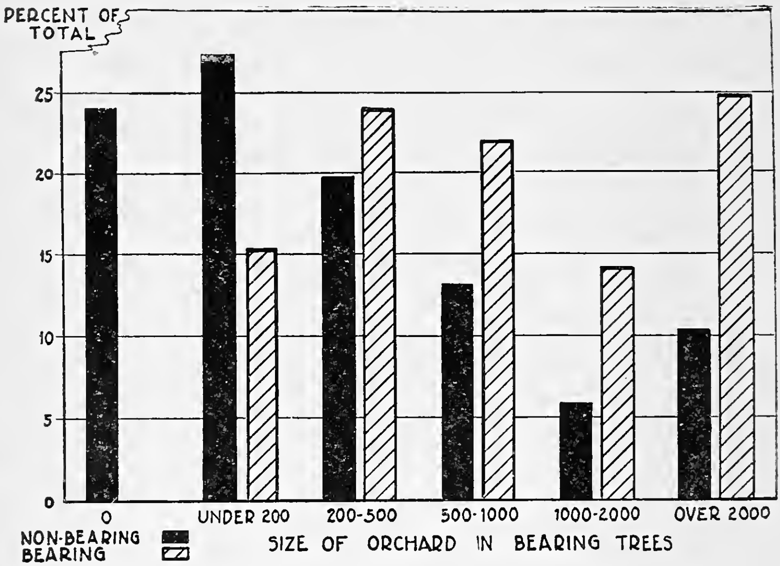


for years and are gradually increasing their plantings. This is indicated by the fact that they reported only 3 per cent of the bearing trees, but nearly 16 per cent of the non-bearing trees.

Recent plantings have been very heavy on small orchards and nearly half the non-bearing trees were reported by men having fewer than 500 trees. Nearly three-fourths of the trees not bearing have been planted by men with comparatively small bearing orchards, or by men just entering the business.

A comparison of the ages of trees in orchards of different sizes shows that those in orchards of 1,000 or more bearing trees are relatively young. Most of them have been set within the past fifteen years. Old trees are found chiefly in the small orchards and the production per bearing tree averages nearly twice that in the large orchards. For this reason the small orchards of the state produce relatively more of the crop than the large orchards. Orchards of fewer than 200 bearing trees produce one-fourth of the crop, and half the commercial production comes from orchards of fewer than 500 bear-

CHART 10. Percentage of all Bearing and all Non-bearing Trees in Orchards of Different Sizes, 1925.



ing trees. It is evident that the small orchard will be a very important factor in the future market.

Preference for the different varieties varies with the size of orchard. The large orchards have fewer varieties, carefully selected with a view to balanced farm organization and market demand. In general, the percentage of McIntosh increases with the size of orchard and the percentage of Baldwin decreases. The large orchards average one-third Baldwin and over one-half McIntosh. There is a tendency for large growers to plant only Baldwin and McIntosh as permanent varieties, at the rate of two McIntosh to one Baldwin. Most of the bearing Wealthy and Wagener trees are in the large orchards as fillers, as are a large proportion of Duchess trees.

Over two-thirds of the trees in small orchards with many varieties are Baldwin. The McIntosh comprises about one-fourth of the average small orchard, although there are many which contain none of this variety. Most of the bearing Gravenstein are also found in small orchards. The conclusion may be drawn that future increases in McIntosh production will come largely from large orchards, while the greater part of the Baldwin crop will be produced on farms with relatively small orchards.

Sources of Income

Most Massachusetts apple growers do not depend solely upon fruit for their income. Specialized fruit farms form only a small percentage of the total number and raise less than 15 per cent of the crop. In many cases fruit growing is a side-line and of secondary importance to the dairy herd. In Middlesex County fruit furnishes 40 per cent of the grower's income; dairying supplies 35 per cent; vegetables, 15 per cent; and poultry, 5 per cent. The remainder comes from a variety of sources. It is significant that in the most highly specialized fruit section of the state dairying is almost as important a source of income as fruit.

In the western part of the state, especially in Franklin County, dairying is more important than fruit, and these two items make up 95 per cent of the income of the average grower. Sales of hay and wages from outside work make up most of the remainder. In Hampshire and Hampden counties dairying is more important than fruit, but poultry, vegetables, hay and other crops furnish a large part of the total farm income.

On most fruit farms there are not more than two principal sources of income. Fruit and dairying are most common in all sections of the state, except in the areas close to Boston. In this section more attention is given to vegetable crops, and fruit and vegetable gardening are the usual combination. This applies to those sections of Essex, Middlesex, Norfolk and Plymouth counties within easy trucking distance of Boston and its suburbs. In other sections, fruit and poultry make a profitable combination on the farm with a moderate size of orchard.

Many specialized growers are combining orchard fruits with small fruits. Raspberries, currants and strawberries are usually planted, and peaches have been successful in a few sections.

Orchard Practice

A part of the survey was concerned with the usual orchard practices common among fruit growers in various sections. The results show to what degree scientific methods have been adopted as well as the practices of successful growers.

Pruning

It was found that 81 per cent of the growers prune every year, although this figure is to some extent misleading, since many growers replied that they "prune some every year". Many orchards are practically untouched and from observation it is estimated that not over two-thirds of the trees are thoroughly pruned every season. Fifteen per cent of the growers stated that they prune only occasionally, while 1 per cent do not prune at all.

Cultivation

Over two-thirds of the orchards are in sod and one-third are handled by clean cultivation or with a cover crop. Many growers reported on more than one orchard, so that the actual number of bearing orchards in cultivation is only about 25 per cent of the total. A wide variety of cover crops was reported, buckwheat, rye and millet being common. The usual practice is to cultivate the young orchard, but leave it in sod after it begins to bear.

Fertilizer

Three growers out of four apply fertilizer in some form every year. A wide variety of materials is used, but nitrate of soda is the most common, 60 per cent of the growers reporting its use. Over half of the growers use barnyard manure. Acid phosphate is used by 7 per cent of the growers, while 4 per cent use a complete fertilizer. Only a few users of sulfate of ammonia were found. Other growers reported the use of bone meal, wood ashes, potash, tankage and wool scourings. Three per cent of the growers use no fertilizer.

Spraying

The number of sprays varies widely. The calyx spray is almost universal. Either the dormant or delayed dormant spray is used by 80 per cent of the growers, the pink by 60 per cent, and the pre-pink by only 32 per cent. Nearly one-fourth of the growers reported the use of sprays in addition to those mentioned. The number varied from one to six, used principally for McIntosh. Dusting is not popular, only thirty growers now using it, and several of them expressed the intention of abandoning it in favor of liquid sprays.

Thinning

Twenty-five per cent of the growers do some thinning, but with many it is not a regular practice. McIntosh is the variety usually thinned, but all of the early varieties are thinned to some extent. Only a few growers reported thinning all varieties. The distance varies with the grower, but one apple to a spur and keeping the fruit from touching are the usual practices. A few growers thin to the recommended distance of six to eight inches. The practice is spreading and many growers are convinced of its value, although unable to do very much thinning on account of lack of time or experienced help.

Production

A total production of 1,712,000 bushels was reported, and of this amount 88 per cent was sold as marketable fruit. The farm consumption is relatively high, due to the large number of small orchards. A small amount of salable fruit is manufactured on the farms, principally for jellies, apple butter and similar products.

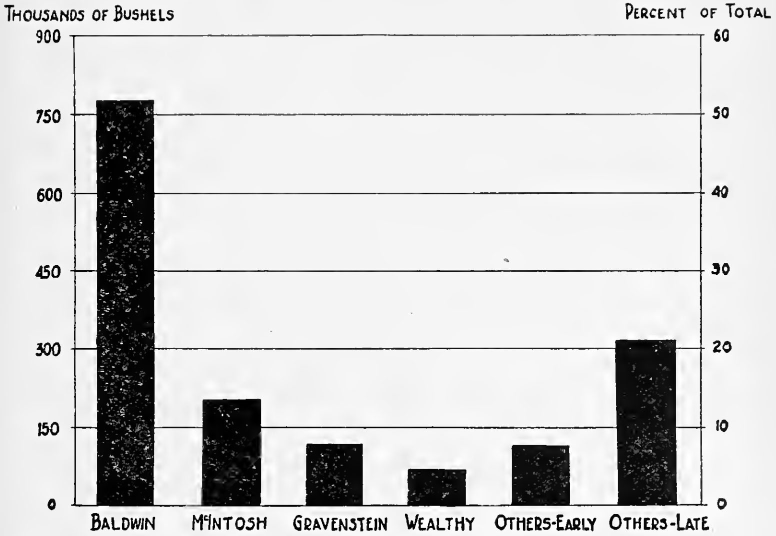
Over 12 per cent of the total production reported was culls or cider apples. In Franklin County 20 per cent of the production was culls, ciders or waste, partly due to poor quality and partly because of the sale of wild apples for cider. In the better commercial sections, the defective and cull fruit averages from 8 to 10 per cent of the total. Two-thirds of the culls are sold for cider, and 13 per cent are made into cider or other apple products on the farm. A few are fed to livestock and apparently about 3 per cent are wasted, most of the waste occurring in the poor fruit sections.

Marketing

Grades

Grading in some form is practiced by two-thirds of the growers. Most of the grading is done by hand, only 80 graders being reported. The favorite graders are the Pease and Cutler with a few machines of each of a half-dozen other makes. The number of grades varies with the grower, the amount and the quality of the crop, the varieties grown, and the custom of the section. Many growers do not distinguish between sorting and grading, and much of the grading reported means nothing more than the removal of small and defective fruit. Three-fourths of the growers sell only one or two grades of apples. Growers reporting one grade do not sell their defective fruit, using it on the farm; when two grades are sold, one of them is usually culls.

CHART 11. Production of Principal Varieties, 1924.



Only 209 growers reported the sale of more than two grades, while 23 reported as many as four or more grades.

Massachusetts apples are sold in three graded and three ungraded classes. The graded classes are Fancy, A and B. The ungraded include one class from which legal grades have been removed; one from which culls and ciders only have been removed; and one which includes all apples as they come from the tree. The usual grades for the growers reporting three grades are A, B and culls or ungraded. Less than 1 per cent of the growers make a practice of putting up a Fancy grade. There is a widespread belief that too close grading is not profitable, and prices received offer some justification for this belief.

The percentage of each grade varies with the variety.* The following table shows the distribution into market classes of the crop of 1924. It will be noted that in every case the highest proportion of apples was sold as "ungraded, culls and ciders out", and that 65 per cent of all apples were sold ungraded. Sixty-three per cent of all graded fruit was found to be in A grade.

By varieties, it is of interest that Delicious apples show the highest percentage of Fancy, more than 10 per cent being reported in this class, in contrast with less than 3 per cent for all varieties. This is to be accounted for by the fact that the market demand for this variety is almost entirely for the better grades. Northern Spy shows a higher proportion of A grade than any other variety, 36 per cent, and the McIntosh stands second with 30 per cent in this grade. McIntosh likewise has the highest percentage of graded fruit. Only 35 per cent of the Baldwin crop was reported graded. This variety is grown largely in small orchards, where comparatively little grading is done.

* Summer varieties include Duchess, Transparent, Williams, Astrachan, etc.
Fall varieties include McIntosh, Wealthy, Gravenstein.
Winter varieties include Baldwin, Northern Spy, Delicious, Wagener, Greening, etc.

TABLE 2. Percentages in Grades of Summer, Fall and Winter Apples, 1924

Grade	Summer	Fall	Winter	Total
Graded:				
Fancy	2.9	5.4	1.69	2.76
A	24.5	28.9	19.95	22.6
B	9.95	10.1	9.6	9.8
Total graded	37.35	44.4	31.24	35.16
Ungraded:				
A and B out	1.75	1.17	1.23	1.24
Culls and ciders out	52.0	44.4	44.5	45.0
Tree run	7.5	9.2	20.5	16.9
Other salable*	1.4	.75	2.22	1.78
Total ungraded	62.65	55.52	68.45	64.92

* "Other salable" includes apples used for farm consumption and for farm manufacture, exclusive of culls and ciders. These probably belong largely with ungraded.

Furthermore, the Baldwin commonly produces few apples of the higher grades, making the cost of grading too high for profit.

Methods of Sale

The method of sale varies with the locality. Fifteen different methods were reported, but four are outstanding. The commission man is the most important figure in marketing the crop, and over one-third of all Massachusetts apples are sold through the various commission houses of the state. Country buyers, including peddlers, handle nearly one-fourth of the crop, and in some sections as much as three-fourths. More than 10 per cent is sold outright to wholesalers and an equal amount goes to retail grocers. Direct sales to consumers in one of several ways account for most of the remainder of the crop.

Door to door sales are most common in the Connecticut Valley and the southeastern part of the state, about 20 per cent of all apples in these districts being so distributed, while less than 8 per cent in Middlesex and Worcester counties are sold by this method.

Roadside stands sell about one-fourth of the apples reported in the southeastern part of the state, while but 4 per cent in Middlesex, Worcester and the western counties are sold in this way.

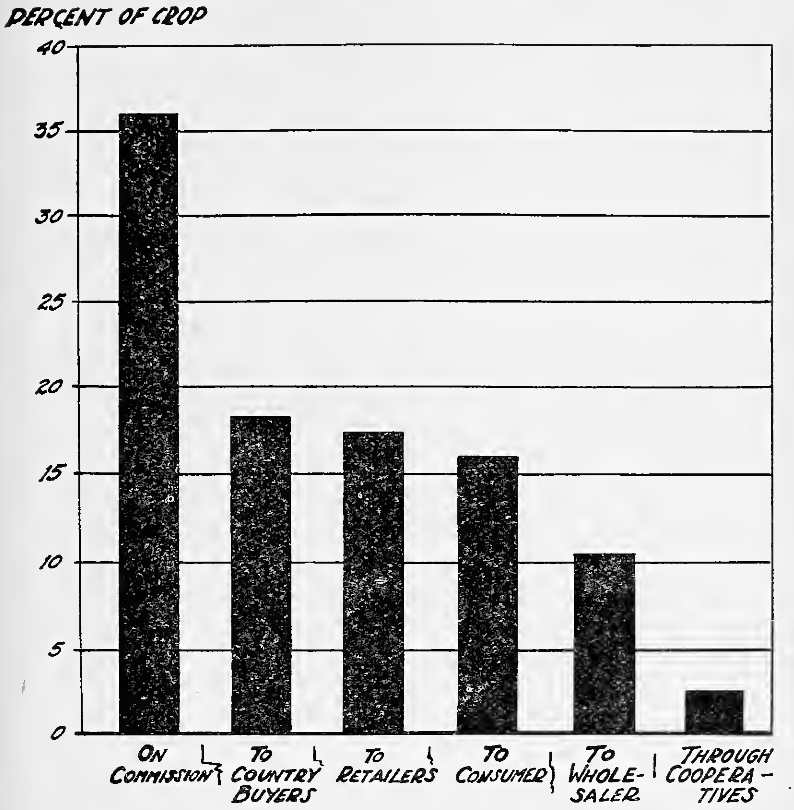
Sales to retailers comprise but 12 per cent of all sales in Middlesex and Worcester counties, although in some other sections retailers receive as high as 34 per cent of all apples.

While sale on commission is the most important method for the state as a whole, its use is by no means uniform. Only 1 per cent in Franklin County are so reported. In the central part of the state where it is used most, an average of 42 per cent of the apples are handled by commission men.

Sales to country buyers, who may be wholesalers, retailers or hucksters, are most common in Franklin County, where they receive 65 per cent of the apples. In the remainder of the state country buyers purchase only 12 per cent of the apples sold. Two per cent of the apples reported were exported, and these mostly on commission. Few exporters buy apples outright.

A comparison of methods of sale and varieties of apples shows that of all apples sold directly to consumers, either at the roadside or from door to door,

CHART 12. Methods of Sale Used by Growers, 1924.



6 per cent are summer varieties, 24 per cent, fall; and 70 per cent winter varieties. Of apples sold to retail distributors, 5 per cent are summer, 21 per cent are fall, and 73 per cent winter varieties. Winter apples comprise 80 per cent of wholesalers' purchases; less than 3 per cent are summer apples, and 16 per cent are fall varieties. Sales on commission are made up of 54 per cent winter apples, 38 per cent fall varieties and 8 per cent summer varieties.

Of 1,200,000 bushels on which the methods of sale were reported, 69,000 were summer apples, 326,000 were fall, and 797,000 winter varieties. Table XIV (appendix) shows that there is considerable difference in the methods of selling early and late varieties. Large growers produce most of the summer and fall apples, which are more perishable than the later varieties and must therefore be marketed as quickly as possible. Over 60 per cent of these apples are shipped to the wholesale markets, nearly half of them to commission men.

Country buyers purchase a smaller percentage of early apples than of the late varieties, because they prefer a storable apple of comparatively low grade. Most of the sales to country buyers are Baldwin. A larger proportion of early than of late apples is sold at roadside stands, automobile traffic being heaviest in the late summer and early fall.

Prices

A study of prices received for apples of different grades shows that graded fruit averages more than 25 cents a bushel above ungraded fruit. Local prices are more valuable to the fruit grower than a general average, and although price information was obtained for all fruit sold, it is not possible to present here all the figures obtained. Two sections, consisting of two towns in Franklin County and three towns in the Nashoba area, have been chosen as typical.

In the Nashoba district apples are commonly sold in boxes and the percentage of graded fruit is higher than in Franklin County, where most apples are sold ungraded and packed in barrels. Sales in the Nashoba area are mostly on commission in Boston, within easy hauling distance. In Franklin County the most common method of sale is to country buyers who come to the orchard, make whatever bargain they can with each grower, and buy the apples at the farm. These differences in method are undoubtedly factors which contribute largely to the differences in price reported from the two sections.

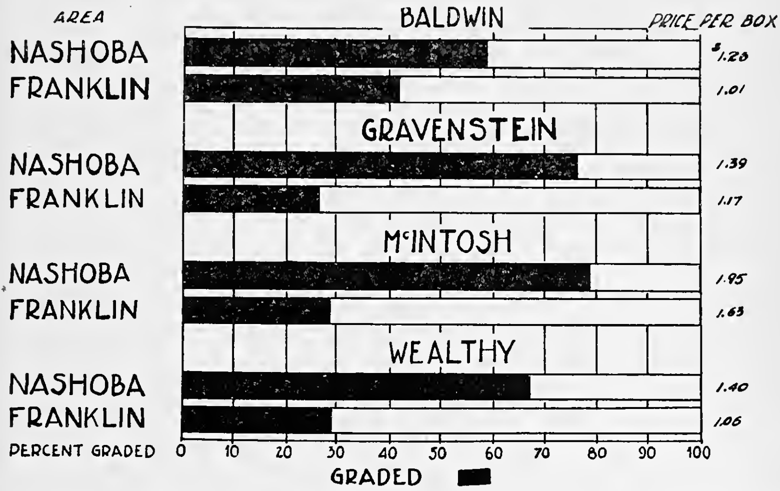
Table 3. Average per Bushel by Grades of Leading Varieties, in Two Selected Districts, 1924

Variety	A	B	Ungraded, Culls and Ciders Out	Tree Run	All Grades
Three Towns in the Nashoba District					
Baldwin	$1.44	$1.18	$1.02	$1.15	$1.26
McIntosh	2.14	1.81	1.58	1.64	1.95
Wealthy	1.49	1.41	1.37	1.15	1.40
Two Towns in Franklin County					
Baldwin	1.12	.91	1.03	.52	1.01
McIntosh	2.04	1.70	1.57	1.45	1.63
Wealthy	1.33	1.03	1.34	.88	1.06

The accompanying chart, Chart 13, presents the comparison of the prices and the proportion of graded and ungraded fruit sold of each of the four leading varieties, Baldwin, Gravenstein, McIntosh and Wealthy, for the two sections under consideration. It will be noted that the average prices in the towns of the Nashoba area run uniformly higher than in the towns of Franklin County for similar varieties and grades. (cf. Table 3). These differences are caused by accessibility of market, methods of sale, quality of fruit, and the amount of grading done, but it is obviously difficult to determine which has the greatest effect on price.

Baldwins, of which 59 per cent are graded in the towns of the Nashoba district, returned an average price of $1.26 per bushel. In the two Franklin County towns, with 41 per cent graded, this variety brought $1.01 a bushel. This margin of 25 cents represents the average difference in price for all grades between the two areas.

CHART 13. Amount of Grading and Average Prices Paid to Growers in Two Typical Sections, 1924.



The greatest difference in price between all graded and all ungraded in both districts is for McIntosh, amounting to a little more than 50 cents a bushel. McIntosh prices averaged from 50 per cent to 100 per cent higher than those received for any other commercial variety. The Baldwin prices are lower than those of any other variety, probably because of the quantities available and the relatively low quality. Prices received for Wealthy and Gravenstein apples average above those of most winter varieties.

Markets

Massachusetts apples are distributed widely, going by carlots to markets as far west as Chicago and as far south as Washington. From the reports of growers it is estimated that 15 per cent of the Massachusetts crop is sold outside the state, principally in New York.

A large amount of fruit in western Massachusetts is sold to storage companies and other dealers from New York State. The Connecticut Valley furnishes fruit to Hartford, Providence and New Haven. Providence is an important market also for the central and southeastern sections, and prices average higher on Rhode Island markets than on the local markets in those sections.

Boston is the most important Massachusetts market, receiving over one-third of the crop. Worcester and Springfield are important markets in the western part of the state, and are supplied almost entirely from nearby producing areas. Smaller cities, such as Pittsfield, Holyoke, Greenfield, Lowell and Haverhill consume large quantities of apples supplied locally. In some cities large quantities are sold by growers to retailers, while in others sales are almost entirely to wholesalers or on commission. Most of the smaller towns and cities are partly supplied with local fruit through door-to-door sales.

Exports

Only 2 per cent of the crop of 1924 was reported as exported. Most exports are handled on commission, the hazards of the business being so great that in general the dealers do not care to buy outright for export. A few growers have exported considerable portions of their apple crop for a good many years. These men have learned to pack for foreign markets so that comparatively few "slack" packages appear among their shipments.

Storage

Growers report available storage space for 919,000 bushels, but less than 20 per cent of the available space was used in 1924. The farm cellar is the usual place of storage, although more storage buildings are built each year. Many growers with young orchards intend to build or enlarge their storage space as their orchards come into full bearing.

Of the 227,000 bushels stored by farmers in 1924, over 50,000 bushels were placed in city storage warehouses. Boston handles half of the fruit going into city storage, but some storage was reported in Worcester, Springfield, Greenfield, Fall River and Providence.

The late winter varieties, such as Baldwin, make up the largest part of fruit stored on farms. These are usually kept until the holiday season or later. Many growers who supply their local markets from storage holdings, frequently have fruit on hand as late as March or April. However, the bulk of the fruit in farm storage is usually disposed of by January.

More McIntosh are stored each year, and they are held for a longer time than formerly. Most of the storage holdings are sold out by the end of the holiday season.

Transportation

Information on methods of transportation shows that at some point in their distribution 95 per cent of all Massachusetts apples marketed are hauled by motor truck. This may be all the distance to market, or the haul may be completed by rail. The same is true of hauls by wagon, which are confined almost entirely to Franklin County shipments. Over 70 per cent of all Massachusetts apples shipped in carlots during the four years 1920 to 1923 were from this county.

Future of the Industry

The future of the apple growing industry in Massachusetts and its profitableness to the farmer depend upon the amount and quality of future production. With favorable growing conditions, there is no doubt but that production of all of the important commercial varieties will increase each year. Large numbers of trees are just coming into bearing and yields will increase with maturity. Many of the large orchards of the state now bearing will not reach full production for at least ten years, and over 300,000 trees not bearing at present will come into bearing during the period. Barring the possibility of a disastrous winter which may kill the trees, the estimated future production, together with the number of bearing trees for the leading varieties, is indicated in the following table.

TABLE 4. Estimate of Future Production of Four Commercial Varieties of Apples on 1754 Farms in Massachusetts, 1924-1940 (bushels)

Year	Baldwin		McIntosh		Wealthy		Gravenstein	
	Bearing Trees	Production	Bearing Trees	Production	Bearing Trees	Production	Bearing Trees	Production
1924	280,000	790,000	118,000	205,000	36,000	66,000	28,000	115,000
1930	310,000	950,000	175,000	400,000	38,000	70,000	32,000	140,000
1935	350,000	1,200,000	235,000	700,000	40,000	75,000	35,000	175,000
1940	375,000	1,300,000	250,000	900,000	35,000	70,000	40,000	200,000

TABLE 5. Estimates of Future Commercial Apple Production in Massachusetts (bushels)

Year	1754 Farms		State Total	Per cent Increase Over 1924
	Four Varieties	Total		
1924	1,200,000	1,500,000	1,750,000	
1930	1,560,000	1,950,000	2,275,000	30
1935	2,150,000	2,730,000	3,185,000	82
1940	2,470,000	3,135,000	3,610,000	107

It is estimated that the total commercial crop of the state will increase at least 100 per cent within fifteen years. The largest part of this increase will be Baldwin and McIntosh, and the latter will undoubtedly show the greatest increase of any variety. In making the above estimates an estimated loss of from 10 to 40 per cent of the trees was deducted, depending upon the variety and age group. The largest deductions were made from the recent plantings, particularly of Baldwin. Allowances were also made for old trees dying out, and for removal of fillers. The estimates for 1935 and 1940 include probable plantings during the next ten years at a continual annual decrease of 10 per cent from the present rate. It is probable that by 1935 plantings will not be sufficient to replace losses of old trees. Annual plantings of at least 30,000 trees are necessary to maintain a million bearing trees.

It is estimated that within ten years 100 of the largest growers of the state will be producing approximately one-half of the crop. On farms of this type a high production per tree and high quality are the rule, and this fact has an important bearing on future estimates of the total crop. Each year will see a larger part of the commercial crop produced by professional fruit growers, in orchards planted during the past ten or fifteen years. Production in the small orchards may be expected to increase on account of recent plantings, but this increase will be partly offset by the dying of old trees which now largely make up this type of orchard. It is probable that the quality of fruit grown in the small orchard will be poorer than that of the large orchard because less care is given to growing, handling and marketing. Most of the small growers do not have the time or equipment to produce and pack the best grades of fruit.

Conclusions

Securing profitable markets for the probable increase in production is a matter of the utmost importance. One possible outlet is the building up of new markets outside of New England. Many dealers consider New York City as a promising market for McIntosh apples. This variety is coming into favor and there is a growing demand for Massachusetts McIntosh because of the excellent flavor and color. A few growers are now selling in Philadelphia, and further development of this market and others west and south is possible, especially for McIntosh.

A larger quantity of high grade home-grown apples, particularly McIntosh, is reducing the sale of Western apples on local markets. Doubtless this supplanting of Western apples can be carried still further.

According to the Federal Census reports the number of bearing trees in other New England states is declining, and while recent plantings have been heavy, they have not been sufficient to offset the dying of old trees. This decline will probably reduce outside competition on local markets to some extent.

Exporters report a growing demand for American apples of good grade in foreign markets. This market should be carefully guarded from apples of poor quality. Indeed, one method of improving the market generally is by keeping low grade apples off the market entirely. Some growers find it more profitable to make apples of B and lower grades into cider and other by-products than to send them to market. More care in growing, grading and packing fruit will mean profits instead of losses in the future.

A strong organization of fruit growers for the marketing of Massachusetts apples should be able to create or find more profitable markets for good grades of apples. An association of this sort could advertise more successfully than any individual. Advertising offers possibilities in building preferences for Massachusetts fruit in local markets; and it is also possible that through well-planned advertising people may be led to use more apples.

Under present conditions, the careful grower will not plant more trees until the market situation has been adjusted. Growing high grade fruit will remain profitable, although it is possible that the increase in crop will have some effect in lowering prices. Owners of small orchards are urged not to increase their plantings unless they are prepared to give their trees the same attention, and produce fruit of the same quality as that grown in the larger orchards.

The growing demand for McIntosh indicates that there will be little demand for other native varieties reaching the market at the same time. Prices of winter varieties will also be affected by the longer storage of McIntosh.

A study of the apple market, including both domestic and foreign demand, is now under way and will furnish definite information on the marketing situation.

APPENDIX

TABLE I. Number of Apple Trees in Massachusetts, by Counties, 1925—Bearing, Non-bearing, Permanent and Filler.

County	Total Trees				Non-Bearing Trees				Bearing Trees			
	Permanent	Filler	Total	Per cent of Total	Permanent	Filler	Total	Per cent of Total	Permanent	Filler	Total	Per cent of Total
Middlesex	334,016	16,061	350,077	35.6	123,984	7,189	131,173	35.7	210,032	8,872	218,904	35.4
Worcester	225,019	23,363	248,382	25.2	98,243	14,368	112,611	30.8	126,776	8,995	135,771	21.9
Franklin	100,198	7,884	108,082	11.1	23,697	4,592	28,289	7.7	76,501	3,292	79,793	12.9
Hampshire	69,377	11,196	80,573	8.2	20,022	2,145	22,167	6.1	49,355	9,051	58,406	9.5
Essex	61,282	5,621	66,903	6.8	17,477	3,181	20,658	5.6	43,805	2,440	46,245	7.8
Hampden	29,944	833	30,777	3.1	7,840	625	8,465	2.3	22,104	208	22,312	3.6
Norfolk	25,663	397	26,060	2.5	9,362	7	9,369	2.5	16,301	390	16,691	2.7
Plymouth	20,703	2,818	23,521	2.4	7,827	1,934	9,761	2.7	12,876	884	13,760	2.2
Bristol	20,779	1,912	22,691	2.3	6,581	750	7,331	2.0	14,198	1,162	15,360	2.5
Berkshire	18,761	3,297	22,058	2.2	12,277	1,217	13,494	3.7	6,484	2,080	8,564	1.4
Barnstable	4,959	481	5,440	.6	2,835	350	3,185	.9	2,124	131	2,255	.4
Total	910,671	73,863	984,564	100.0	330,145	36,358	366,503	100.0	580,556	37,505	618,061	100.0

TABLE II. Age of Apple Trees in Massachusetts, by Counties, 1925

Age	Barnstable Number of Trees	Barnstable Per cent of Total	Berkshire Number of Trees	Berkshire Per cent of Total	Bristol Number of Trees	Bristol Per cent of Total	Essex Number of Trees	Essex Per cent of Total
Under 5 years	2,871	52.8	11,864	53.7	5,483	24.1	13,362	20.0
5–9 years	597	11.0	1,630	7.4	4,237	18.7	9,431	14.1
10–14 years	561	10.3	6,333	28.7	8,513	37.6	11,198	16.6
15–19 years	798	14.7	1,883	8.6	3,265	14.4	3,932	5.9
20–29 years	170	3.1	150	.7	517	2.3	2,275	3.4
Over 30 years	260	4.8	198	.9	666	2.9	13,421	20.1
Unclassified	183	3.3	....	....	10	....	13,284	19.9
Total	5,440	100.0	22,058	100.0	22,691	100.0	66,903	100.0

Age	Franklin Number of Trees	Franklin Per cent of Total	Hampden Number of Trees	Hampden Per cent of Total	Hampshire Number of Trees	Hampshire Per cent of Total	Middlesex Number of Trees	Middlesex Per cent of Total
Under 5 years	17,505	16.2	5,210	16.9	11,150	13.8	71,103	20.3
5–9 years	17,988	16.6	5,113	16.6	19,855	24.6	97,560	27.9
10–14 years	17,500	16.2	8,227	26.8	19,146	23.8	58,210	16.6
15–19 years	9,934	9.2	3,875	12.6	6,516	8.1	20,664	5.9
20–29 years	14,141	13.1	3,653	11.8	6,808	8.5	20,149	5.8
Over 30 years	17,526	16.2	4,016	13.1	10,500	13.0	59,345	16.9
Unclassified	13,488	12.5	683	2.2	6,598	8.2	23,046	6.6
Total	108,082	100.0	30,777	100.0	80,573	100.0	350,077	100.0

Age	Norfolk Number of Trees	Norfolk Per cent of Total	Plymouth Number of Trees	Plymouth Per cent of Total	Worcester Number of Trees	Worcester Per cent of Total	Total Number of Trees	Total Per cent of Total
Under 5 years	3,793	14.6	3,106	13.2	56,630	22.8	202,077	20.5
5–9 years	8,459	32.5	9,054	38.5	85,880	34.6	259,804	26.4
10–14 years	6,320	24.3	9,822	41.8	43,150	17.4	188,980	19.2
15–19 years	1,653	6.3	828	3.5	11,618	4.7	64,966	6.6
20–29 years	831	3.2	512	2.2	7,176	2.9	56,382	5.7
Over 30 years	1,189	4.5	195	.8	25,921	10.4	133,237	13.5
Unclassified	3,815	14.6	4	....	18,007	7.2	79,118	8.0
Total	26,060	100.0	23,521	100.0	248,382	100.0	984,564	100.0

TABLE III. Number of Fillers by Varieties,

Bearing and Non-Bearing, 1925

Variety	Non-bearing	Bearing	Total	Per cent of Total
Transparent	1,648	2,836	4,484	6.1
Astrachan	631	453	1,084	1.5
Williams	108	590	698	.9
Duchess	3,898	4,136	8,034	10.9
Wealthy	18.059	16.455	34.514	46.8
McIntosh	5,188	4,432	9.620	13.0
Baldwin	200	1,228	1,428	1.9
Delicious	1,228	45	1,273	1.7
Wagener	4,330	3,095	7,425	10.1
Others	1,068	4,235	5,303	7.1
Total	36,358	37,505	73,863	100.0

Table IV. Age of Trees Planted as Fillers, 1925

Age	Non-bearing	Bearing	Total	Per cent of Total
Under 5 years	21,595		21,595	29.2
5–9 years	14,763	11,256	26,019	35.3
10–14 years		22,701	22,701	30.7
15–19 years		3,093	3,093	4.2
20–29 years		391	391	.5
Unclassified		64	64	.1
Total	36,358	37,505	73,863	100.0

Table V. Principal Varieties of Apples in Massachusetts—Bearing and Non-Bearing Trees, 1925, with Commercial Production, 1924.

Variety	Total Trees		Non-Bearing Trees		Bearing Trees		Commercial Production	
	Number	Percent of Total	Number	Per cent of Total	Number	Per cent of Total	Bushels	Per cent of Total
Baldwin . .	387,863	39.4	108,285	29.5	279,578	45.2	788,471	51.5
McIntosh .	235,268	24.0	116,844	31.9	118,424	19.2	205,116	13.4
Wealthy . .	65,857	6.7	29,415	8.0	36,442	5.9	66,284	4.3
Gravenstein .	49,424	5.1	20,839	5.7	28,585	4.7	114,786	7.5
Delicious . .	42,055	4.3	32,685	8.9	9,370	1.5	12,888	.8
Duchess . .	20,331	2.1	9,046	2.5	11,285	1.8	21,114	1.4
Transparent .	16,252	1.6	6,743	1.8	9,509	1.5	20,461	1.3
Wagener . .	15,472	1.5	5,751	1.6	9,721	1.6	*	*
Greening . .	13,997	1.4	2,116	.6	11,881	1.9	26,079	1.7
Astrachan .	13,545	1.3	6.089	1.6	7.456	1.2	22,247	1.5
Northern Spy .	10,919	1.1	3,166	.9	7.753	1.3	13,565	.9
Williams . .	7,406	.7	2,249	.6	5,157	.8	17,370	1.1
Others . .	106,175	10.8	23,275	6.4	82,900	13.4	223,031	14.6
Total . .	984,564	100.0	366.503	100.0	618.061	100.0	1,531,412	100.0

*Production included in "Others".

Table VI. Age of Trees of Leading Varieties of Apples in Massachusetts, 1925

Age	Total Trees		Baldwin		McIntosh		Wealthy		Gravenstein		Others	
	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total
Under 5 years	202,077	20.5	55,062	14.1	60,950	25.2	18,289	27.8	11,056	22.4	56,720	23.0
5–9 years	259,804	26.4	69,785	17.9	95,156	40.9	20,135	30.6	14,714	29.4	60,014	24.4
10–14 years	188,980	19.2	58,064	15.0	58.759	24.8	18,452	28.0	8,113	16.5	45,592	18.5
15–19 years	64,966	6.6	30,521	7.8	11,415	5.0	6,007	9.1	3,396	7.0	13,627	5.5
20–29 years	56,382	5.7	34,641	8.9	4,323	1.9	1,839	2.8	4,306	8.8	11,273	4.6
Over 30 years	133,237	13.5	103,475	26.6	1,588	.7	419	.6	4,759	9.7	22,996	9.3
Unclassified	79,118	7.8	36,315	8.9	3,077	1.4	716	1.0	3,080	6.2	35,930	14.6
Total	984,564	99.7	387,863	99.2	235,268	99.9	65,857	99.9	49,424	100.0	246,152	99.9

Table VII. Age of Trees of Less Important Varieties* of Apples in Massachusetts, 1925

Age	Delicious		Duchess		Transparent		Wagener		Greening		Astrachan		Northern Spy		Williams		Others	
	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total	Number of Trees	Per cent of Total
Under 5 years	25,065	59.6	5,473	26.9	3,986	24.5	1,233	8.0	880	6.3	3,344	24.7	1,211	11.1	1,489	20.1	14,039	13.2
5–9 years	10,925	26.0	6,759	33.2	6,084	37.4	7,606	49.3	1,439	10.3	4,669	34.5	2,846	26.1	1,640	22.1	18,046	17.0
10–14 years	4,797	11.4	5,643	27.8	4,012	24.7	4,906	31.7	2,493	17.8	1,990	14.7	3,427	31.4	1,370	18.5	16,954	16.0
15–19 years	778	1.9	1,336	6.6	840	5.2	643	4.1	688	4.9	828	6.1	975	8.9	672	9.1	6,867	6.5
20–29 years	229	.5	486	2.4	525	3.2	952	6.1	1,341	9.6	755	5.6	350	3.2	445	6.0	6,190	5.8
Over 30 years	144	.3	325	1.6	520	3.2	32	.2	5,804	41.5	1,150	8.5	1,524	14.0	1,367	18.5	12,130	11.4
Unclassified	117	.3	309	1.5	285	1.8	100	.6	1,352	9.6	809	5.9	586	5.3	423	5.7	31,949	30.1
Total	42,055	100.0	20,331	100.0	16,252	100.0	15,472	100.0	13,997	100.0	13,545	100.0	10,919	100.0	7,406	100.0	106,175	100.0

*Included in "Others" in Table VI.

TABLE VIII. Average Number of Trees in Bearing Orchards of Different Sizes, 1925

Size of Orchard in Bearing Trees	Bearing Trees	Non-Bearing Trees	Total Trees per Orchard	Per cent Bearing
0	. . . .	925	925	. . . .
1–199	109	116	225	48.5
200–499	310	151	461	67.2
500–999	672	238	910	73.8
1000–1999	1,315	318	1,633	80.5
Over 2000	3,490	856	4,346	80.3
Average—all orchards	354	209	563	63.0

TABLE IX. Percentages of Trees and Production in Orchards of Different Sizes, 1925

Size of Orchard in Bearing Trees	Per cent of Growers	Per cent of Non-Bearing Trees	Per cent of Bearing Trees	Per cent of All Trees	Per cent of 1924 Production
0	5.4	23.9	. . . .	8.9	. . . .
1–199	49.4	27.3	15.3	19.8	19.2
200–499	27.4	19.7	23.9	22.4	28.2
500–999	11.5	13.1	21.9	18.6	23.4
1000–1999	3.8	5.8	14.2	11.0	13.0
Over 2000	2.5	10.2	24.7	19.3	16.2
Total	100.0	100.0	100.0	100.0	100.0

TABLE X. Commercial Production of Apples by Varieties, Graded and Ungraded, 1924 (bushels)

Variety	Graded	Ungraded	Per cent Graded	Total
Baldwin	285,038	503,433	36.4	788,471
McIntosh	107,439	97,677	52.2	205,116
Wealthy	28,001	38,283	42.4	66,284
Gravenstein	44,467	70,319	38.7	114,786
Delicious	5,125	7,763	39.7	12,888
Duchess	8,227	12,887	38.9	21,114
Transparent	7,808	12,653	38.2	20,461
Greening	7,970	18,109	30.5	26,079
Astrachan	7,579	14,668	34.1	22,247
Northern Spy	6,380	7,185	47.0	13,565
Williams	8,078	9,292	46.5	17.370
Others	41,778	181,253	18.7	223,031
Total Commercial Production	557,890	973,522	36.4	1,531,412
Total Culls, Ciders and Waste				181,328
Total Production . . .				1,712,740

TABLE XI. Commercial Production of Leading Varieties of Apples, by Counties, 1924 (bushels)

Variety	Barnstable	Berkshire	Bristol	Essex	Franklin	Hampden	Hampshire	Middlesex	Norfolk	Plymouth	Worcester	Total
Baldwin	425	562	3,672	44,136	159,936	38,956	73,116	317,067	9,196	4,527	136,878	788,471
McIntosh	175	5,025	4,363	5,641	11,196	8,471	15,319	78,158	3,868	2,380	70,520	205,116
Wealthy	115	1,050	1,111	2,195	2,490	3,759	8,149	29,783	1,236	1,666	14,730	66,284
Gravenstein	135	...	770	3,623	1,623	1,637	1,877	84,521	2,060	461	18,079	114,786
Delicious	50	...	2,346	270	690	16	534	2,139	1,855	608	4,380	12,888
Duchess	8	600	729	1,304	1,224	2,010	2,469	9,718	256	360	2,436	21,114
Transparent	62	...	1,266	499	183	215	380	14,620	261	422	2,553	20,461
Greening	45	6	185	327	9,195	3,247	5,277	3,206	1,137	127	3,327	26,079
Astrachan	90	50	1,140	1,489	843	361	1,238	14,306	178	454	2,098	22,247
Northern Spy	70	9	79	682	1,410	3,027	2,341	3,381	339	255	1,972	13,565
Williams	20	...	635	634	72	1	109	13,388	113	66	2,332	17,370
Others	946	2,900	5,708	23,410	7,008	12,016	30,014	69,162	9,700	2,763	59,404	223,031
Total	2,141	10,202	22,004	84,210	195,870	73,716	140,823	639,449	30,199	14,089	318,709	1,531,412

TABLE XII. Total Production of Leading Varieties of Apples in Massachusetts, by Grades, 1924

Grades	Early Summer*		Wealthy		Gravenstein		McIntosh		Baldwin		Others		Total	
	Bushels	Per cent of Total	Bushels	Per cent of Total	Bushels	Per cent of Total	Bushels	Per cent of Total	Bushels	Per cent of Total	Bushels	Per cent of Total	Bushels	Per cent of Total
Commercial:														
Fancy	2,475	2.9	2,934	4.4	2,061	1.8	17,373	8.5	12,642	1.6	4,876	1.8	42,361	2.8
A	20,971	24.5	18,063	27.2	32,841	28.6	62,322	30.4	172,315	21.8	40,207	14.8	346,719	22.6
B	8,522	9.9	6,538	9.9	8,542	7.4	24,593	12.0	89,557	11.4	11,982	4.4	149,734	9.8
Ungraded, A and B out	1,502	1.8	466	.7	1,023	.9	3,151	1.5	10.524	1.3	2,410	.9	19,076	1.2
Ungraded, culls out	44,491	52.0	31,636	47.7	61,691	53.8	79,653	38.9	357,548	45.3	112,348	41.5	687,367	44.9
Tree Run	6,404	7.5	6,410	9.7	7,768	6.8	16,256	7.9	129,193	16.4	93,842	34.6	259,873	17.0
Farm Manufacture	71	...	4	...	38	...	36	...	1,215	.2	631	.2	1,995	.1
Farm Consumption	1,158	1.4	233	.4	822	.7	1,732	.8	15,477	2.0	4,865	1.8	24,287	1.6
Total Commercial Production	85,594	100.0	66,284	100.0	114,786	100.0	205,116	100.0	788,471	100.0	271,161	100.0	1,531,412	100.0
Culls, Ciders and Waste														
Culls and Ciders Sold	491		25		160		242		6,592		119,334		126,844	
Culls and Ciders Manufactured	25		...		60		65		2,411		22,650		25,211	
Culls and Ciders Consumed on Farm	1,056		27		150		12		7,861		14,778		23,884	
Shrinkage and waste	820		72		15		171		1,847		2,464		5,389	
Total Culls, Ciders and Waste**	2,392		124		385		490		18,711		159,226		181,328	
Total Production	87,986		66,408		115,171		205,606		807,182		278,560		1,712,740	

*Includes Transparent, Astrachan, Williams, Duchess, etc.
**Where only one figure for ciders was given, all varieties were included under "Others."

TABLE XIII. Percentages of Apples Sold by Different Methods, by Counties, 1924

Method of Sale	Barnstable	Berkshire	Bristol	Essex	Franklin	Hampden	Hampshire	Middlesex	Norfolk	Plymouth	Worcester	Total
Door to Door	28.5	6.1	12.3	9.6	8.2	17.0	30.3	6.3	25.8	18.3	9.3	10.3
Roadside	24.9	14.3	23.4	5.3	2.4	1.0	1.3	3.6	13.5	45.0	1.9	4.3
To Peddler	11.4		4.4	15.7	4.7	13.8	14.0	4.3	6.5		1.6	5.6
To Retailer	29.4	12.3	34.0	15.2	5.2	24.0	6.3	7.5	31.4	28.0	15.8	11.8
To Wholesaler		1.7	11.0	19.2	9.0	4.6	17.5	7.7	8.7		16.0	10.8
To Country Buyer			1.2	27.4	65.0	11.1	16.6	17.5	5.0	2.1	18.6	18.1
On Commlssion	5.7	65.5	13.8	6.7	.7	27.2	10.0	47.0	8.9		29.2	33.9
Farmers' Market					.2		1.0	.7		6.4	.5	.5
Co-operatively						.9	2.4	2.1			5.6	2.3
For Export				.7	1.6		.1	3.0			1.5	2.0

TABLE XIV. Percentage of Summer, Fall and Winter Apples Sold by Different Methods, 1924

Method	Summer	Fall	Winter	Total
Direct to Consumer	6.2	6.5	12.3	10.3
Roadside Market	8.8	6.4	3.0	4.3
Peddler	4.3	3.5	6.5	5.6
Retailer	11.5	10.0	12.5	11.8
City Wholesaler	6.1	7.4	12.6	10.8
Country Buyer	8.9	11.2	21.7	18.1
On Commission	51.0	46.5	27.2	34.0
Farmers' Market	1.0	.8	.4	.5
Co-operatively	.1	4.7	1.5	2.3
For Export	1.7	2.4	2.0	2.1

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SOIL REACTION AND BLACK ROOT-ROT OF TOBACCO

By **P. J. ANDERSON, A. VINCENT OSMUN** and **W. L. DORAN**

Black root-rot is a serious menace to successful tobacco production in the Connecticut Valley. The causal fungus is found in most tobacco soils of the Valley. Low temperature during the growing season, and high lime conditions in the soil, both stimulate its activity. Injury may vary all the way from complete destruction of the crop, on heavily limed soils in cold growing seasons, to a damage scarcely noticeable. Not only does the root-rot depress yield, but it may injure quality of leaf as well.

There are but two known methods of combating the disease: first, through control of lime conditions in the soil; and secondly, through the use of root-rot resistant strains of tobacco. This bulletin reports results of research on the former.

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SOIL REACTION AND BLACK ROOT-ROT OF TOBACCO

By P. J. ANDERSON, A. VINCENT OSMUN and W. L. DORAN[1]

Black root-rot probably causes greater loss to the tobacco growers of the United States than does any other disease. In the Connecticut Valley, according to published records, it has caused varying amounts of damage since 1906. It was probably prevalent long before that time, but had escaped attention. Within the last decade its ravages have been reduced considerably through improved cultural practices, based on a better knowledge of the effect of certain environmental factors on the virulence of the disease. Nevertheless it still takes its annual toll from the crop and, as one of the causes of "tobacco sick" soils, is an important factor in tobacco production in Massachusetts.

Symptoms of Black Root-Rot

The first symptom of the disease which the grower notices in the field is that the tobacco doesn't grow. The plants remain stunted, with narrow, thick, tough leaves and either a starved yellow color or, where the nitrogen supply is high, a very dark green color commonly called "black" by the tobacco man. On hot days the leaves wilt and "flag" more quickly than healthy tobacco plants. The dwarfed plants "top out" prematurely. Only rarely is a field equally affected in all parts. Usually there are "patches" from a square rod to several acres in extent, where the tobacco is short while in other parts of the field the growth is normal. In the diseased "patches" the plants are frequently very uneven in growth.

From the above ground symptoms, however, it is not possible for even an expert to be sure that this is black root-rot. Other troubles such as brown root-rot, lack of fertilizer, or water-logged soil may produce the same appearance. One must dig the plants and wash the soil from the roots to see the lesions which are the unmistakable signs of black root-rot. Normal young roots are white, but on a diseased plant many are black (brown at first), either throughout their length or frequently only in segments, with other segments appearing normal. Most of the ends of the small roots are black, indicating that in digging the plant, the root broke at this point and the decayed end was left in the soil. The tissue of the smaller roots is rotted through, but on the large roots there occur enlarged, rough, scurfy lesions which may or may not kill the interior tissues. Frequently the tap root is entirely rotted off at the bottom and there is an increased number of laterals. This results in a brush-work of intermingled brown, black and white small roots just above the blackened end of the main root. The brown lesions are caused by the same organism (*Thielavia basicola* Zopf)[2] which later produces the black ones, the color depending on the age of the lesion. The character which distinguishes this disease from all other tobacco diseases is the coal black color of parts of the roots. The reduced root system is unable to se-

1 During the first year of this investigation the work was conducted by G. H. Chapman, formerly research professor of Botany at this Station.

2 McCormick (Conn. Agr. Exp. Sta. Bul. 269, 1925) considers this *Thielaviopsis basicola* (Berk.) Ferraris.

cure sufficient water and soil nutrients for normal growth of the above ground parts of the plant, hence the dwarfed slow growth and "flagging" on hot days.

Black root-rot may also occur in the seed-beds, where it exhibits the same symptoms, viz., slow growth, yellow or "black" color of leaves, "flagging," and black rotted roots. Many of the plants also die. The beds look very uneven.

Previous Investigations

In the first experiment station publication which recorded and described the disease in the Connecticut Valley, Jenkins and Clinton (5:7)[3] stated:

"It is not definitely known whether an acid, alkaline or a neutral soil is best adapted to the growth of the fungus, which we know can grow in the soil itself apart from the tobacco root, but it is reasonable to suppose that this factor may have its influence."

Later (5:8):

"One of the growers whose fields suffered severely was inclined to lay it to the excessive use year after year of potash fertilizers, which gradually accumulated in the soil, and especially to the use of the carbonate of potash."

The first, and up to the present date the most important, contribution on the relation of soil reaction to root-rot was a brief circular by Briggs (1) describing results of experiments in Connecticut in 1907. His conclusions are best summarized in the following statements which we quote:

"The results of the writer's investigations thus far indicate that the tobacco is much more severely injured by the fungus on fields where the soil has been made alkaline by the long-continued use of large amounts of lime, ashes and fertilizers containing carbonate of potash."

"In all cases it was found that the plots on which carbonate of potash was used gave the smallest plants and the lowest yields. The use of lime with the carbonate of potash still further diminished the yield. The use of carbonate of potash and lime with cottonseed meal and ground fish gave a yield of but 900 pounds per acre. This yield was 200 pounds less to the acre than when no fertilizer was used and was only a little more than half the yield obtained from some of the other plots."

In pot experiments he found that:

"In soils free from root-rot, the use of 1 per cent of lime gave a better growth of tobacco than where no lime was used. This shows that the lime does not injure the tobacco directly . . . . The use of hydro-chloric acid, on the other hand, increased the yield by about 10 per cent although this acid carries no plant food . . . . The root systems of the plants in all the pots to which lime or carbonate of potash was added were badly diseased . . . . The roots of the plants grown in acid-treated soil were perfectly clean and white, and entirely free from the fungus."

All of Briggs' experiments were with naturally infested soils from fields where the soil acidity had been greatly reduced by use of alkaline fertilizers and lime. The reaction of the soil was not determined either before or after the treatments which he applied.

Johnson and Hartman (7:53-60) determined the influence of soil reaction on root-rot by growing plants in pots after adding graduated quantities of

3 Numbers in parenthesis refer to bibliography at the end of this bulletin. Numbers after the colon give the page on which statement referred to may be found.

calcium hydroxide to a naturally very acid soil inoculated with macerated diseased roots. Acidity was determined in terms of lime requirement according to the Truog method. From these experiments they concluded that:

" . . . . the highest acidity practically eliminated damage from root-rot, but that heavy infection still occurred in fairly acid soil."

When they inoculated all the soils heavily with spores of the fungus *just before planting,* they found that:

"A heavy infestation apparently reduced the efficacy of the acid soils to nothing, at least in the presence of a susceptible variety. The disease appeared, in fact, more virulent in the most acid soil."

This last experiment indicates that the effect of the acid soil is not to increase the resistance of the plant but to retard the development of the fungus.

They also tested in the field the effect of application of acid fertilizers and concluded that:

"For Wisconsin conditions . . . . application of acid fertilizers to soil, alkaline or neutral in reaction, will not reduce infection by *T. basicola.*"

Chapman (2) in connection with an investigation of "tobacco sick" soils of Massachusetts made 300 determinations of the lime requirement of tobacco soils and correlated them roughly with the condition of the crop and prevalence of root-rot. He concludes (2:38) that:

"Soils with a lime requirement up to 3000 pounds CaO per acre are not producing good crops as a rule and are comparatively free from root-rots. Those with a lime requirement of from 3000 to 8000 pounds CaO per acre are in good tobacco condition; but in this group, pathogenic fungi are abundant in the soil, and the plants during certain seasons, are very liable to suffer from root-rots caused by some of these fungi. Soils with a lime requirement of 8000 pounds CaO up are usually comparatively free from such fungi, and even in unfavorable seasons, little disease is found."

He explains the relative freedom from root-rot of the soils which show the lowest lime requirement by assuming that these soils are too alkaline for the development of the fungus. His results on this point are at variance with those of Johnson and Hartman. The poor yield is attributed to the unfavorable effect of a too alkaline soil on the tobacco plant.

Chapman questioned the lime requirement method as a means of measuring the acidity of the soils.

Need of Further Investigation

We may summarize the results of all the investigations recorded up to the present: A soil made less acid by the use of lime, carbonate of potash, or ashes favors the development of black root-rot. When, however, the acidity is increased, there is a corresponding reduction in amount of root-rot injury until a point is reached where it is negligible. In regard to the particular degree of acidity which must be attained to escape root-rot and, in general, the correlation of reaction and infection throughout the soil range, Briggs gives no information while Johnson and Hartman and Chapman had contradictory results. In view of this situation and the fact that it is now commonly accepted that the development of fungi is proportionate to *intensity* of acidity as measured by the hydrogen ion concentration method, rather than the *amount* of acidity, as measured by the lime requirement method, there seemed to be need for further experimentation.

Two related problems concerned (1) the effect of lime on tobacco in the absence of root-rot and (2) the effect of the timothy cover crop.

In regard to the first, it is safe to assume that the growers considered lime beneficial, else it would not have come into such general use. Briggs found that 1 per cent of lime in disease-free soil increased growth. Hartwell and Damon (3:437) include tobacco among the lime loving plants. McCall (9) reports that, on heavy loam soil in Maryland, lime increased the yield of tobacco, but that direct applications of lime tended to lower the quality of the leaf. Hutcheson and Berger (4:7) found that, in Virginia, lime at first gave a larger yield but the tobacco was coarse and "bony." In the later years of the experiments, however, they found the tobacco reduced both in quantity and quality by lime. It is quite possible that in this case the later effects were due to root-rot rather than to the direct effect of lime. This is true in other similar experiments where the first effects were good but in later years there was a reduction. Since in most cases root-rot is not mentioned, one cannot be sure whether the experimenter was measuring the effect of the lime or of root-rot. This difficulty renders worthless most of the literature on the effect of lime on tobacco.

During the last decade, the use of timothy as a cover crop has come into considerable favor with tobacco growers of the Connecticut Valley. It reduces washing and blowing of the light soils during the long period between tobacco crops and also adds considerable humus to the soil. Some growers also have the impression that it reduces black root-rot by neutralizing in some way the ill effect of lime. When this experiment was begun there were no published records of experiments to determine the effect of its use on the succeeding crops of tobacco. It became desirable, therefore, to test by accurate experiments its immediate and cumulative effects.

The Five-Year Experiment

In 1921 a series of experiments was, therefore, started for the purpose of answering these three questions:

1. What effect does application of lime have on growth of tobacco in the absence of root-rot?
2. What is the relation between severity of infection and acidity as measured by hydrogen ion concentration?[4]
3. What is the effect of a timothy cover crop on the yield and quality of tobacco and on the severity of root-rot?

During the last five seasons Havana tobacco has been grown continuously on a field of 1.2 acres on the experiment station farm where no tobacco has been previously raised for at least 8 years. The soil is apparently of the Gloucester series. The field was divided into 24 plots of 1-20 acre each according to the diagram presented in figure I. It will be noted from this diagram that limed strips of plots alternated with unlimed strips in one direction; while at right angles, there were duplicate strips of plots (1) without

4 In measuring reaction in terms of hydrogen ion concentration method, a neutral soil or other substance is designated by the number pH 7, acid substances by the numbers below 7, alkaline substances by those above 7 up to 14. Thus a soil designated by 6 is slightly acid; 5, much more so; 4, more than 5; etc. We are not concerned here with the alkaline end of the scale since all our tobacco soils are naturally acid, and fall within the range from 4 to 7. Even when a large amount of lime is applied, they do not remain above 7 for any considerable time. The degrees of acidity are usually written pH 5, pH 4.5, etc.

cover crop (2) with timothy cover crop and (3) with clover cover crop.[5] One-half of the field was inoculated while the duplicate half was not inoculated. All cultivation was in the direction of the cover crop strips, thus avoiding as far as possible carrying the fungus to the uninoculated half.

The limed plots were treated year by year as follows:

1921, ground limestone,		4000 lbs. per acre
1922, precipitated lime	(51 per cent CaO),	2000 " " "
1923, agricultural lime	(60 " " CaO),	4000 " " "
1924, no lime		
1925, no lime		

The fertilizers applied each year just before setting the plants are described in the following table.

Fertilizers Used—Pounds per Acre

Material	1921	1922	1923	1924	1925
Cottonseed Meal	1200	1200	1481	1270	828
Ammonium Sulfate	120	120	62	90	100
Dry Ground Fish	180	180	247	195	200
Acid Phosphate	160	160	....	....	....
Precipitated Bone	120	120	432	276	....
H. G. Sulfate of Potash	240	240	278	252	280
Ammo-Phos	....	....	....	....	234
Total rate per acre	2020	2020*	2500†	2083‡	1642‡

* Plus a quickly available side dressing at the second hoeing.
† Plus 250 lbs. nitrate of soda per acre applied in July.
‡ Equivalent to 3000 lbs. per acre of a 5-4-5 fertilizer.

That half of the field which was inoculated (see Figure 1) was first inoculated in 1921 by setting in it diseased plants taken from a badly infested seed bed. In order to secure heavier infection on the inoculated half, a handful of soil from a heavily infested greenhouse bed was placed in the furrow where each plant was set in 1922. The inoculated half of the field was again inoculated just before setting the plants in 1923, when two cartloads of heavily infested soil from a greenhouse bed were scattered broadcast over it and harrowed in.

Timothy and clover cover crops were sown after harvesting the tobacco in 1921, 1922, and 1923. None were sown in 1924.

Soil samples for pH determination were taken from all plots each year, and the hydrogen ion concentrations which were determined are recorded in Table I.[6] These soil samples were taken before the ground was broken in

5 Since the clover winter-killed every year, its effect if any must be attributed to the very small growth between sowing and freezing of the soil.

6 These and subsequent determinations were made by F. W. Morse, Henri D. Haskins, and L. S. Walker, chemists on the staff of the Massachusetts Agricultural Experiment Station. The determinations were made on air dried soils by the Clark and Lubs colorimetric method. The water extract was made by adding 200 cc. of distilled water to 20 grams of air-dry soil in a flask and allowing it to stand about 1 hour with frequent shaking. The extract was then filtered by turning the soil mixture on a small filter in a large funnel. The first portions of the filtrate were returned to the soil flask until the extract was running clear By this time, the paper was filled with soil, and the filtration was through soil supported by a small paper. By this means, any absorption by the paper was reduced to its lowest terms.

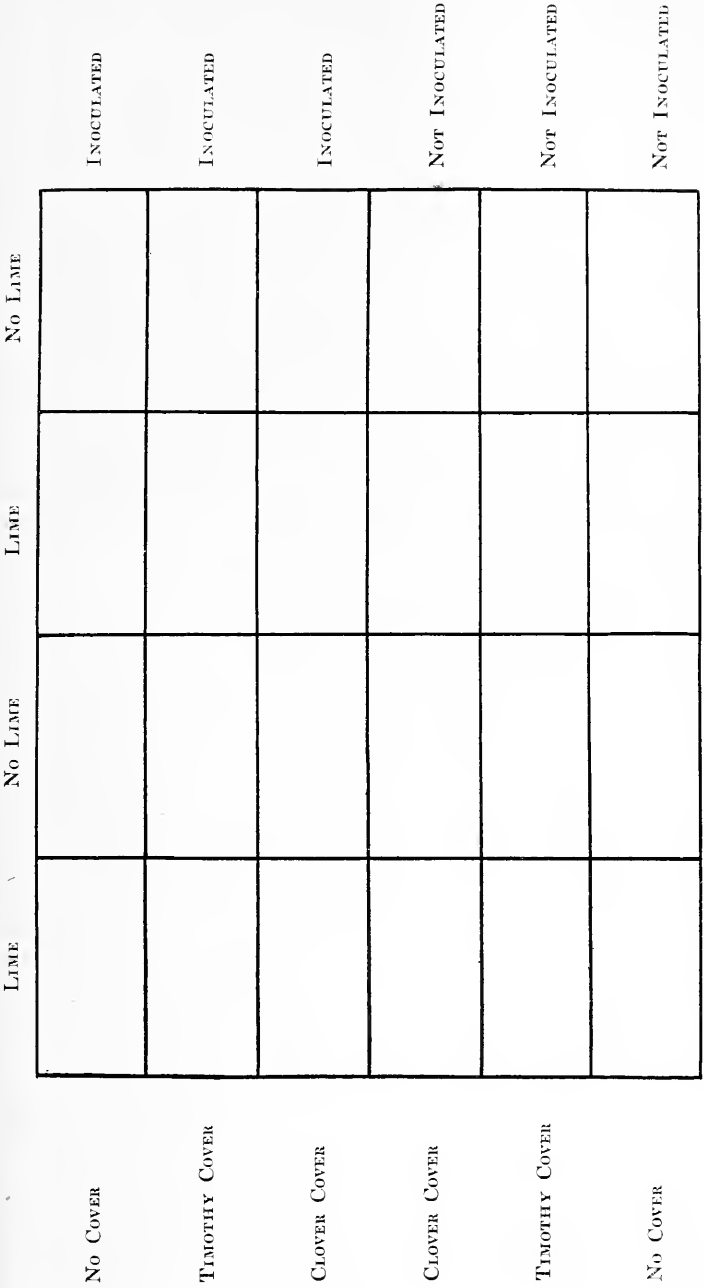


FIGURE 1. Diagram of Field Experiments Showing Inoculation, Cover Crop, and Lime Treatment of Plots.

May in 1922, 1923, and 1924, and in April, 1925.

During each growing season observations on growth were recorded. Immediately after the crop was harvested roots from each plot were examined for black root-rot.

No yield records were taken in 1921 because of the uneven stand, due principally to setting at different periods. When the crop of 1922 was harvested, 160 plants from the four center rows of each plot were weighed. These green weights are recorded in Table I. At the time of harvesting in 1923, 1924, and 1925, the tobacco from each entire plot, except for the borders, was hung, stripped, and cured separately. The weights of cured leaves are tabulated by plots in Table I, and the results summarized in Table II. Sorting records for the crop of 1925 were made, and the percentage for each grade and length of leaf in each plot is given in Table III.

The work and results of each of the last four years are presented separately before discussing conclusions from the whole experiment.

Season of 1922

Throughout the summer it was apparent that (1) the timothy strips were making a poorer growth than those which had no cover crop or had clover; (2) the limed plots were making a better growth than the corresponding unlimed plots both on the inoculated and uninoculated parts of the field; (3) the inoculated half was not making as much growth as the uninoculated. These field observations were all substantiated by the yield records as given in Table I and summarized in Table II. This shows that by liming there was a gain of 12 per cent both on inoculated and uninoculated plots; by the use of a timothy cover crop there was a loss of 13 per cent on the inoculated and 18 per cent on the uninoculated half; and finally that the inoculated half was 15 per cent lighter all through than the uninoculated half. After cutting the tobacco, some of the roots from each plot were dug and washed. Lesions were found on practically all of the roots from the inoculated plots, but were not much worse on the limed than on the unlimed plots. They were located especially on the large roots at the bottom of the stalk where the roots had to grow through the handful of infested earth that was deposited at planting time. A few lesions were found on the roots from the uninoculated half.

In 1922 the use of lime was associated with an increase in the yield of tobacco, and was not associated with any great increase in the amount of root-rot.

This year there was a decided loss in weight of tobacco following the timothy cover crop. The percentage of loss from timothy was not as heavy on the inoculated half as on the uninoculated half.

Inoculated plots uniformly yielded a lighter crop than uninoculated, although examination of the roots did not indicate very severe infection. Most of the injury was in the region where the handful of infested soil was in contact with the roots and not general over the whole root system.

Season of 1923

About the middle of the summer it became apparent that in the infected half of the field the tobacco on the limed strips was lagging behind the unlimed strips in growth. This difference increased throughout the summer. The fact that a similar difference was not apparent on the uninoculated half indicated that the dwarfing effect was due to the influence of lime on the root-rot. When the roots were examined it was found that (1) the disease was very bad on all the inoculated limed plots, (2) the lesions were fairly prevalent on the roots of the unlimed inoculated plots (but much less so than on the limed plots), (3) there were frequent lesions on the uninoculated limed plots, and (4) only rarely could a lesion be found on the uninoculated, unlimed plots.

The results noted in 1923 may be summarized as follows: In the inoculated half of the field, the yield on limed plots was 16 per cent less than the yield on unlimed plots. In the uninoculated half of the field, the yield on limed plots was still 7 per cent more than the yield on unlimed plots, but this was a drop of 12 per cent from the previous year. On the inoculated half of the field even the unlimed plots suffered some loss from black root-rot, the yield being about 8 per cent less than on unlimed plots in the uninoculated part of the field.

In 1923 there was a small loss from the use of timothy, and, as in the preceding year, this loss was less on the inoculated than on the uninoculated plots.

Season of 1924

It became apparent early in the season that the limed plots were making a much poorer growth than the corresponding unlimed ones. This was particularly striking on the inoculated half, but it was also quite apparent from the poor growth that there were many places in the uninoculated half where root-rot was doing serious danage. It was plainly evident that root-rot was no longer confined to the inoculated end of the lime strips but that it was now present even to the extreme opposite end. A second very apparent fact was that there were some very good plots of tobacco (unlimed) in the inoculated part of the field, showing that the effect of very thorough inoculation was not lasting when the soil condition was not right. These observations during the growing season were substantiated by examination of the roots after the crop was harvested. It was then found that, irrespective of inoculation, the number of lesions was very small on all plots which had not been limed. On the limed strips, lesions were particularly numerous on the roots from the inoculated plots; but many of the roots from the other end were in just as serious condition, while others were relatively free. This indicated that on the uninoculated limed plots, the infestation was still uneven. Nevertheless it seemed to be spreading rapidly in these. The cured weights per acre as given in Tables I and II showed a loss from liming of 17 per cent on the inoculated plots and 12 per cent on the uninoculated plots.

In 1924, the fourth year of the experiment, the loss from black root-rot on limed plots was more severe than in the previous years, although no lime was applied this year.

In the unlimed plots, the amount of root-rot was small, whether or not the plots were inoculated. The yield on the inoculated plots was only 4 per cent less than on the corresponding uninoculated plots.

For the third successive year a reduction in yield was associated with the use of the timothy cover crop.

Season of 1925

The effect of lime on black root-rot and yield and the effect of timothy cover crop on yield were never more conspicuous than in 1925, although no cover crops had been planted and no lime applied since 1923.

Throughout the season growth was much superior in unlimed plots to growth in limed plots. It was apparent that on plots which had had a cover crop of timothy in previous years the tobacco was making a better growth than on plots which had never had a cover crop of timothy. In other words, the depressing effect of timothy which had been observed in previous years was not in evidence after this cover crop was omitted for one year. There was no visible difference in growth between the inoculated and uninoculated halves of the field. It was evident that, regardless of inoculation, black root-rot was causing loss in all limed plots.

When the roots from all plots were examined at harvest time, an average of 98 per cent of the plants in all limed plots was found to be severely infected with black root-rot. In unlimed plots an average of only 14 per cent of the plants showed symptoms of this disease, and infection on them was slight. The previous cover crop was found not to affect the amount or severity of black root-rot. Infection, as revealed by the examination of the roots, was the same on the inoculated and uninoculated parts of the field. Brown root-rot was slightly more pronounced on limed than on unlimed plots, but the difference was small.

The soil in limed plots had, in April 1925, pH values from 6.4 to 7.0. In all these, plants were severely infected and there were no visible differences between them as regards infection. The soil in unlimed plots ranged in pH values from 4.5 to 5.0. Infection in these plots was absent or slight, and there were no appreciable differences between them.

In 1925 the yield on inoculated plots was no less than the yield on plots not inoculated. The black root-rot fungus was evidently present in all plots, but had not become established in unlimed plots because of unfavorable soil conditions. It had, however, become established in limed but uninoculated plots. The black root-rot fungus is probably present in all tobacco soils, but it is evident that it causes no loss in soils having a reaction unfavorable to the fungus.

The average reduction in yield due to liming (35 per cent) was greater in 1925 than in any previous year of the experiment, although no lime was applied in either 1924 or 1925. During this two-year period without more lime added, the soil in the limed strips had, however, become slightly less acid. The omission of lime for two years on land on which tobacco was grown continuously did not result in any immediate relief from black root-rot. The greater loss in 1925 was probably not directly due to any change in the soil reaction, but to the fact that the soil is becoming more completely infested with the fungus.

The injurious action of lime as expressed in black root-rot was not more pronounced in its effect on yield than on quality and value. This is recorded in Table III under per cent darks, seconds, mediums, fillers, and brokes. The average per cent mediums and seconds on limed plots was 6, and on unlimed plots 22. The average per cent fillers on limed plots was 39 and on unlimed plots 17.

In 1924, for the third consecutive year, the use of timothy cover crop was associated with a reduction in yield. No cover crop was sown in 1924. In

1925 the plots which had previously had a timothy cover crop yielded more than plots on which a cover crop had never been grown. The average increase of plots which had had timothy cover crop over plots which had had no cover crop was 17 per cent. The increase following timothy was greater on limed than on unlimed areas. An examination of roots showed that after the omission of timothy cover crop for one year there was no significant difference between the amount or severity of brown root-rot on plots with and without timothy cover crop. The depressing effect of timothy cover crop on tobacco seems to disappear if the cover crop is omitted for but a single year.

Discussion of the Five-Year Experiment as a Whole

Occurrence of Thielavia in Tobacco Soils and Rate of Infestation

This fungus probably occurs to a limited extent in all of our soils. It has been shown that it occurs on the roots of nearly a hundred other species of plants besides tobacco (6). Many of these are common cultivated and weed plants. Further investigation would undoubtedly show that there are many other hosts. But even though its host plants were not present—they do not seem to be necessary—it apparently lives indefinitely in the soil on dead organic matter. In the examination of tobacco roots from fields which appeared quite normal and healthy above ground there are usually found occasional lesions of black root-rot. The reason that most Connecticut Valley tobacco fields do not suffer severely from black root-rot is not the absence of the fungus, but the maintenance of a soil condition which is unfavorable for its rapid propagation. Soil reaction is probably the most influential factor. An extensive survey of Massachusetts tobacco soils has not been made, but those which have been tested have been fairly acid with a reaction ranging between pH 4.5 and 5.8 except where they have been limed within a few years. Within this range there seems to be very little spread and the degree of infestation is light. But when raised above this range by application of lime or other alkaline substances, conditions are made more favorable to growth of Thielavia and the soil becomes more heavily infested. Increase in degree of infestation however is a slower process than has been commonly supposed. Most investigators of the disease have assumed that when acidity was reduced the disease would immediately become serious. In our own experiments it was not until the second year after liming was started that a high infestation was secured. We have seen a number of cases where growers have applied lime or wood ashes and the effect the first year was an increase in the yield of tobacco. It was only in the second or third year after liming that the trouble became serious. Hutcheson and Berger (4:7) noticed in their experiments that the first effect of lime was beneficial but its ultimate effect was to reduce the yield. It has been the common experience of those who have tried to produce the disease by soil inoculation that their first attempts were unsatisfactory. Since infection of the roots is local, i.e., the fungus does not travel far from the point where it enters the root, the amount of damage is in direct proportion to the number of places at which the root has been infected by the fungus. The degree of soil infestation must therefore be high before the disease becomes serious.

Similarly it is probable that a return of infested soil to a more acid condition will not be immediately followed by a great reduction in the amount of black root-rot. The results in 1925 indicate that the omission of lime and the continuous culture of tobacco do not quickly result in the disappearance of black root-rot injury. Further field work on this point is in progress.

Effect of Lime on Yield of Tobacco in the Absence of Root-Rot

It has been previously mentioned (p. 121) that certain investigators have found that the yield of tobacco was increased by liming the soil, and one of the objects of the work at the Massachusetts Agricultural Experiment Station was to determine whether such was the case under our conditions and if so, to measure the extent of increase. This was also a necessary preliminary to drawing any conclusion as to the effect of liming on root-rot. No records of yields for the first year of the experiment (1921) were made. The records of the second year show an increase of 12 per cent on both the inoculated and uninoculated parts of the field. Theoretically, this should have been larger the first year, since root-rot must have taken a slight toll the second year. During the third year the loss from root-rot more than counterbalanced the gain from lime on the inoculated part, and there was a total loss of 16 per cent. Even on the uninoculated part, root-rot was beginning to reduce the gain which would otherwise have been anticipated from liming, but there was still a final gain of 7 per cent on this half. During the fourth year of the experiment, root-rot had increased to such an extent that it more than overcame the benefit of the lime on the uninoculated part, and we had a final loss even on that side of 12 per cent as opposed to a 17 per cent loss on the inoculated part. In 1925 root-rot had increased so much that the benefit of lime was overcome even more and the loss was about 35 per cent on both the inoculated and uninoculated areas. This is a much greater loss than could have been predicted, since at the previous rate of progress the loss would have been about 17 per cent.

In answer to the first question which was proposed as the object of this experiment we may state that the immediate effect of lime in this soil was to increase the yield. In this case it was 12 per cent the second year. Undoubtedly, the degree of increase from liming depends on the reaction of the soil before application is made. On a soil less acid than this, one would hardly expect the same degree of increase.

How Acid Should the Soil Be?

It has again been demonstrated that the ultimate effect of heavy applications of lime is to increase root-rot and thus reduce yield. The facts that (1) neutral calcium salts such as land plaster do not produce this effect and (2) other alkaline substances such as carbonate of potash do produce it, show that the influencing factor is not the calcium but the alkaline character of the lime. The less acid or neutral soil thus produced does not render the tobacco plant more susceptible to attack but it favors the growth of the fungus and results in a larger number of lesions on the root system. Although there are probably no tobacco soils free from Thielavia, it is apparent that many of them, by virtue of their acid reaction, are so nearly free that their infestation is negligible; while others, by virtue of their less acid reaction, are so heavily infested as to render profitable tobacco growing impossible. The all important question now is: Just where is the dividing line between safety and certain loss? Just what degree of acidity must a soil possess in order to be safe from root-rot?

The data on the soil and crop of 1924 are valuable in determining the location of the dividing line, because at that time the soil must have more nearly reached an equilibrium after the treatment of the three preceding years, and because this equilibrium was not disturbed by artificial inoculation or application of lime in 1924. Correlating for that year the root inspection records, the yield and sorting records and the soil reaction records, we find that root-rot was not serious on any of the twelve plots which had an average reaction of slightly over 5; but that it caused serious damage on all the inoculated and most of the uninoculated plots with an average of 5.9. By using individual plot records it may be confined more closely. Especially instructive is the record of plot 13 which kept a reaction of 5.5-5.6 throughout the three years and which was inoculated as thoroughly as any other plot in the field for three years; but on the 4th year only an occasional lesion on the roots could be found and it was the best plot in the field. Similarly, an inspection of the individual limed plots indicates pretty severe loss at 5.8.

In 1925, soil reactions were determined in April and in October. The pH values were found to have changed considerably during the growth of the tobacco in 1925. This was especially conspicuous in the limed plots, in which the soil became more acid, probably because of the removal of some of the lime by the crop. The pH values determined in April are indicative of the environment in which the crop grew. The reaction of plots without lime was between pH 4.5 and 5.0, and in these plots black root-rot caused no apparent loss. Limed plots had pH values between 6.4 and 6.9, and in all of them black root-rot caused serious damage. There were this year no plots having pH values between 5.0 and 6.4, and so the critical point cannot be located any more closely than has been done above on the basis of the results in 1924.

Experiments in pots in the greenhouse, which are to be described in a later paper, have led us to the conclusion that loss from black root-rot occurs whenever the pH value of the soil is 5.9 or higher, and that loss from black root-rot does not occur at pH 5.6 or below, except in exceptionally cold soils.

We may *therefore conclude that the critical point is somewhere between 5.6 and 5.9.* It is apparent however that there cannot be in reality a critical *point* but rather a critical *region,* below which damage from root-rot may be expected to be little if any, and above which root-rot is almost certain to cause trouble. There are at least three reasons why this region cannot be defined more accurately than the limits given above:

1. The transition from a soil reaction unfavorable for growth of Thielavia to a reaction which favors is a matter of degree—not of plus and minus.

2. During a very warm summer the critical region would probably be higher since a higher soil temperature reduces the effect of root-rot, as has been shown experimentally by Johnson and Hartman (7:60). A cold summer on the other hand would probably depress the critical region toward the acid range.

3. On compact, poorly drained soil black root-rot is commonly worse than in looser soil in the same field, due probably to the difference in the rate of leaching and to lower soil temperature. This also is in accord with the experimental results of Johnson and Hartman (7:80). It is not improbable that

on such a soil the location of the critical region would be lower. On the basis of the yields of the last three years it may be stated that, as the acidity of the soil becomes less above 5.9, the loss caused by black root-rot becomes greater. (The upper limit of alkalinity has not been determined.) Plots on the limed areas in this experiment may be placed in four groups on the basis of the pH values of their soils. These are correlated with average yields as follows:

pH 5.9	to 6.1	—	yield	1233	pounds
" 6.1	" 6.2	—	"	1183	"
" 6.2	" 6.3	—	"	1120	"
" 6.3	" 6.4	—	"	1039	"

We have, then, quantitative evidence of the increasing injury from black root-rot which results when by the addition of the lime the soil is made less and less acid to a point beyond pH 5.9.

How Much Lime May Be Used with Safety?

If the soil has reached such a point, and if it is seriously infested with the black root-rot fungus, what then may be done? If no further lime is applied and if tobacco is continuously grown on such soil, the loss of lime by leaching and by removal in the plant will gradually result in a more acid condition. Of course the loss from black root-rot may be so great as to make tobacco growing on such land unprofitable. Continuous tobacco, no further liming, and the use of acid fertilizers, such as sulfate of ammonia and sulfate of potash, are all the remedial measures to be suggested at this time. A quicker method of increasing soil acidity is desirable, and this matter is now under investigation.

The Effect of Timothy

Since timothy is extensively used and widely recommended as a cover crop for tobacco soils, it was assumed at the outset that it was known to increase the yield of tobacco by virtue of the organic matter which was added to the soil or the plant food which was saved from leaching through its use. It was included in the present experiment to see whether it influenced the damage from black root-rot and as a check against the clover cover crop which was supposed to increase root-rot because it is a host plant of Thielavia. At the end of the first season, therefore, it was a surprise to find that both the inoculated and uninoculated timothy plots showed a reduction in yield—13 per cent and 18 per cent on the inoculated and uninoculated plots respectively. It could not have been a result of the timothy depleting the soil water because 1922 was an extremely wet year. Losses from the use of timothy both on the inoculated and uninoculated plots, but in a smaller degree, were also recorded in 1923 and 1924. Certain plots at times showed small increases over adjacent plots without cover, but considering the experiment as a whole, the conclusion is inescapable that the effect of timothy has been to decrease both the yield and value of the tobacco. This is in agreement with data recently published by Jones (8) who reports an average decrease in yield of 13 per cent associated with the use of the timothy cover crop. The percentages of loss during two of the years were not so high on the inoculated as on the uninoculated plots, but the reverse was true the third year. Certainly there was not, on the whole, sufficient evidence from either the yield data or the examination of the roots to prove that timothy had any influence on the prevalence or severity of black root-rot.

In 1925, after one year's omission of cover crops, the plots which had had timothy cover crops yielded 17 per cent more than the plots which had never had cover crop. It would appear from this that the depressing effect of timothy cover crop quickly disappears and is replaced by a beneficial effect when the cover crop is not sown for one year. This increase following timothy after an interval of one year was greater on limed than on unlimed plots. In this connection it is interesting to consider the previous depressing effect of timothy on limed versus unlimed plots. For the three years previous to 1925, the average reduction in yield associated with the use of timothy cover crop was 5 per cent on limed plots and 10 per cent on unlimed plots.

When the roots of the plants on the timothy plots were compared with those on the adjacent plots without cover in years previous to 1925, it was found that many of the laterals—especially the lower ones—were brown and dead. The symptoms were quite typical of the disease which is now commonly called brown root-rot. The disease was not entirely lacking in any of the plots but was certainly more pronounced on the timothy plots. On the timothy plots which had been limed, black root-rot was also present, and it was not always possible to separate the influence of the two; but on the unlimed plots the brown root-rot was unmistakable. Brown root-rot, then, is apparently one of the causes of depressed yields on the timothy plots. It is known that timothy in rotation encourages this disease, and it is not surprising that we should now find the same effect from timothy used as a cover crop. This, however, is not a satisfying explanation, because we do not yet know what brown root-rot is. Whether or not it is caused by soil organisms or by toxins or malnutrition has never been determined. We are not even sure that all the tobacco-sick soil troubles which we include under the title of brown root-rot are the same. The only characters they have in common are the presence of some dead brown roots and consequent reduced growth.

Pure Culture Experiments on the Relation of H-ion Concentration to Growth of Thielavia

From the preceding, it is apparent that the adverse effect of lime on tobacco is due to the favorable influence of an alkaline reaction on the growth of Thielavia. In order to see whether this conclusion is supported by growth of the fungus in pure culture, synthetic culture media (Czapek's) were prepared and adjusted to the following reactions: 1.5, 2.0, 3.05, 3.45, 3.8, 3.9, 4.25, 4.55, 5.35, 6.05, 6.2, 7.2, 7.9, 8.55, 8.9, 9.6, 9.9, 11.05, 12.1, and 12.9. The reactions were determined both colorimetrically and electrometrically. Three series of cultures were made, one in tubes and the others in Petri dishes. Records of measurements and notes on growth were made at intervals of 3 or 4 days. Briefly summarized, the results were: On all cultures between 6.05 and 12.9 the growth consisted of a dense black mat of mycelium on the surface and dark hyphae under the agar. Both chlamydospores and conidia were produced in great abundance. Within this range no difference in character or quantity of growth could be observed. Apparently the reaction was optimum throughout this entire range. But below this it was otherwise. At 5.35 the rapidity of growth began to decrease. Below 5.35, all growth on the surface ceased and even under the surface it was progressively more scanty down to 3.05. Below this, growth ceased altogether. The production of chlamydospores also decreased progressively with the scantiness of growth until there were none at all at 3.05. A few conidia were produced even to the most acid point where mycelium grew.

Since in pure culture the fungus will grow even at reactions which are more acid than any tobacco soils, it is pertinent to ask why we do not have loss from root-rot below 5.5. The answer is probably to be found in the difference between conditions which the fungus encounters in a sterile artificial medium and what it encounters in its natural medium, the soil. In the latter case it meets keen competition from other soil organisms and it is only the strong vigorous growers that get the available food and thrive. But, as was noted above, Thielavia at 5.35 is beginning to lose its vigor and at more acid ranges it dwindles to nothing. When in its weakened condition due to unfavorable reaction it is being crowded out by other organisms better adapted to acid conditions, it is not strange that Thielavia should be able to make but little headway at 5.35 or lower. Incidentally it should be kept in mind that Thielavia does occur sparingly on roots in more acid soils, and the lesions are just as pronounced but are not numerous enough to cause much loss. The critical point at which vigor of growth begins to diminish is thus lower than 6.05 and higher than 5.35. Thus it must fall somewhere in the region which we have called the critical region, and the results from the pure culture tests support those of the field tests.

Summary

1. The immediate effect of liming an acid soil was to increase the yield of tobacco.

2. If sufficient lime is added, black root-rot is ultimately promoted, and there is consequently a reduction in yield.

3. Black root-rot is present in most soils but is more injurious in nearly neutral soils because the causal fungus, *Thielavia basicola*, grows more rapidly and vigorously in a nearly neutral medium.

4. In the field under experimentation, black root-rot caused little or no loss in soils more acid than pH 5.6. It caused severe loss on all soils less acid than pH 5.9. It should be understood that this critical region between pH 5.6 and 5.9 is an intermediate zone which may be shifted to a somewhat higher or lower position by variations in temperature and compactness of soil, and by differences in the degree of infestation of the fungus in the soil. Growth of the fungus in pure culture on media confirmed the results in the field.

5. As the soil becomes less acid above pH 5.9, the loss from black root-rot increases. The upper limit of alkalinity has not been determined.

6. After repeated applications of lime brought the soil reaction to a point favorable to the fungus, the omission of lime for two years, with tobacco grown continuously meanwhile, did not result in any immediate reduction in the severity of black root-rot.

7. If, because of extreme acidity, lime is considered necessary, it should be applied with great caution and in small applications, always preceded by determinations of soil reaction in order to avoid approaching too closely the danger point of pH 5.9.

8. The use of timothy cover-crop was found to have no significant effect on the prevalence of black root-rot.

9. The use of timothy cover-crop reduced the yield of tobacco for three consecutive years. This effect was associated with brown root-rot.

10. When timothy cover crop was omitted for one year, the depressing effect of timothy quickly disappeared and was replaced by a beneficial effect. In these experiments the yield on plots so treated exceeded by 17 per cent those without cover crop.

Literature Cited

1. Briggs, L. J. The field treatment of tobacco root-rot. U. S. Dept. Agr. Bur. Plant Indus. Circ. 7: 5-8. 1908.
2. Chapman, G. H. Tobacco investigations, progress report. Mass. Agr. Expt. Sta. Bul. 195: 1-38. 1920.
3. Hartwell, B. L. and S. C. Damon. The comparative effect on different kinds of plants of liming an acid soil. R. I. Agr. Expt. Sta. Bul. 160: 407-446. 1914.
4. Hutcheson, T. B. and D. J. Berger. Experiments with bright tobacco and other crops grown on bright tobacco farms. Va. Agr. Expt. Sta. Bul. 233: 3-19. 1923.
5. Jenkins, E. H. and G. P. Clinton. Root-rot of tobacco. Conn. Agr. Expt. Sta. Bul. of Immediate Information 4: 1-11. 1906.
6. Johnson, James. Host plants of Thielavia basicola. Jour. Agr. Res. 7: 289-300. 1916.
7. Johnson, James and R. E. Hartman. Influence of soil environment on the root-rot of tobacco. Jour. Agr. Res. **17**: 41-86. 1919.
8. Jones, J. P. Havana seed tobacco as influenced by timothy cover crop. Mass. Agr. Expt. Sta. Circ. 73: 1-3. 1925.
9. McCall, A. G. Fertilizers for Maryland soils. Md. Agr. Expt. Sta. Bul. 247: 117-151. 1922.

Table I. Treatment, Yields, and Reaction Analyses by Plots throughout the Five Years of the Root-Rot Experiment

Plot	Inoculation	Cover Crop 1921–24	Lime in May 1921	pH May 1922		Lime in May 1922	Green Weight 160 Plants Sept. 1922 Lbs.	pH May 1923		Lime in May 1923	Cured Leaves Lbs. per Acre 1923	pH May 1924		Cured Leaves Lbs per Acre 1924	pH April 1925		Cured Leaves Lbs. per Acre 1925
1	+	None	None	5.0	Average 5.11	None	396	5.2	Average 5.56	None	1231	4.9	Average 5.01	1453	4.6	Average 4.76	1131
2		Timothy		5.2			201	6.0			1372	5.2		1320	4.6		1362
3		Clover		5.1			345	5.2			1358	4.9		1449	5.0		1389
4	—	Clover		5.1			349	5.5			1590	4.8		1468	5.0		1184
5		Timothy		5.2			348	5.7			1457	5.0		1528	4.8		1237
6		None		5.0			387	5.8			1670	5.3		1608	4.6		1187
7	+	None	Ground Limestone 2 tons per acre	5.4	Average 5.73	Precipitated Lime 1 ton per acre	323	6.2	Average 6.06	Agricultural Lime 2 tons per acre	976	6.0	Average 5.9	1150	6.9	Average 6.7	696
8		Timothy		6.2			353	6.3			891	5.8		1315	6.7		1050
9		Clover		6.2			349	6.2			1216	6.0		1182	7.0		748
10	—	Clover		5.6			388	5.7			1599	6.0		1324	6.4		766
11		Timothy		5.5			374	6.2			1373	5.7		1500	6.5		1005
12		None		5.4			477	5.8			1500	5.8		1354	6.7		632
13	+	None	None	5.6	Average 5.70	None	378	5.5	Average 5.68	None	1472	5.5	Average 5.03	1621	4.7	Average 4.72	1492
14		Timothy		5.8			348	5.6			1245	5.0		1354	4.8		1344
15		Clover		5.7			301	5.6			1486	4.9		1566	4.8		1196
16	—	Clover		5.8			430	5.6			1641	5.0		1563	4.7		1303
17		Timothy		5.7			356	6.3			1269	5.2		1522	4.8		1433
18		None		5.4			441	5.5			1231	4.6		1488	4.5		1273
19	+	None	Ground Limestone 2 tons per acre	5.3	Average 5.77	Precipitated Lime 1 ton per acre	393	6.1	Average 6.05	Agricultural Lime 2 tons per acre	1132	5.8	Average 5.9	1278	6.5	Average 6.65	820
20		Timothy		6.0			391	6.0			1245	6.6		1117	6.7		888
21		Clover		6.5			394	6.2			1415	5.8		1257	6.7		796
22	—	Clover		5.5			471	6.0			1886	5.8		1313	6.4		732
23		Timothy		6.0			388	6.0			1316	5.8		1207	6.9		994
24		None		5.3			486	6.0			1401	5.6		1137	6.7		714

TABLE II. Summary of Yields for 1922, 1923, 1924, and 1925

Pounds per Acre

Treatments	1922 Green	1923 Cured	1924 Cured	1925 Cured
Average of all limed plots:				
Inoculated	7340	1146	1217	868
Not inoculated	8620	1579	1356	807
Average of all unlimed plots:				
Inoculated	6560	1361	1461	1319
Not inoculated	7700	1476	1535	1269
Average of timothy cover plots:				
Inoculated	6460	1193	1277	1161*
Not inoculated	7320	1354	1439	1167*
Average of plots without cover crop:				
Inoculated	7450	1203	1375	1034
Not inoculated	8960	1450	1472	951
Average of all plots:				
Inoculated	6960	1253	1338	1076
Not inoculated	8160	1494	1443	1038

Percentage Gain (+) or Loss (—)

From liming:				
Inoculated	+12	—16	—17	—34
Not inoculated	+12	+ 7	—12	—36
From timothy cover:				
Inoculated	—13	— 1	— 7	+12*
Not inoculated	—18	— 7	— 2	+23*
From inoculation:				
Limed	—15	—27	—10	+ 8
Unlimed	—15	— 8	— 5	+ 4

*Timothy not sown in 1924, no cover crop plowed under in 1925.

Table III. Sorting Record of Crop of 1925

Plot	Treatment	pH*	Yields per Acre Lbs.	Darks		Seconds		Mediums		Fillers	Brokes
				Per cent	Length Inches	Per cent	Length Inches	Per cent	Length Inches	Per cent	Per cent
	No Lime:										
1	No cover crop	4.6	1131	50.9	15–25	24.9	15–25	0.6	Not sized	15.8	7.8
2	Timothy	4.6	1362	56.0	15–25	18.7	15–23	None		16.0	9.3
3	Clover	5.0	1389	49.3	15–27	22.9	15–23	None		21.5	6.3
4	Clover	5.0	1184	53.6	15–25	17.9	15–23	0.9	21–23	20.4	7.0
5	Timothy	4.8	1237	51.6	15–25	21.7	15–23	2.5	21–25	17.8	6.4
6	No cover crop	4.6	1187	51.2	15–27	21.1	15–25	2.8	21–25	17.8	7.1
	Lime:										
7	No cover crop	6.9	696	59.8	15–21	0.5	15	None		39.7	None
8	Timothy	6.7	1050	44.4	15–21	27.9	15–21	None		27.0	0.7
9	Clover	7.0	748	46.5	15–21	3.0	15. 19	None		48.6	1.9
10	Clover	6.4	766	54.9	15–21	1.9	15–19	None		43.2	None
11	Timothy	6.5	1005	65.6	15–23	5.3	15–19	None		27.5	1.6
12	No cover crop	6 7	632	41.7	15–23	1.5	15–19	None		56.1	0.7
	No Lime:										
13	No cover crop	4.7	1492	56.8	15–27	23.5	15–25	0.6	Not sized	13.6	5.5
14	Timothy	4.8	1314	55.6	15–27	16.6	15–23	None		17.2	10.6
15	Clover	4.8	1196	50.8	15–27	22.3	15–23	0.6	Not sized	16.4	9.9
16**	Clover	4.7	1303	54.9	15–27	14.7	15–25	2.2	21–25	15.4	12.5
17	Timothy	4.8	1433	51.5	15–27	21.5	15–23	1.6	21–25	17.5	7.9
18	No cover crop	4.5	1273	51.2	15–27	19.2	15–25	2.6	21–25	17.5	9.5
	Lime:										
19	No cover crop	6.5	820	51.9	15–21	5.6	15–19	None		41.6	0.8
20	Timothy	6.7	888	63.1	15–21	9.3	15–19	None		27.1	0.5
21	Clover	6.7	796	46.5	15–21	6.0	15–19	None		45.0	2.5
22	Clover	6.4	732	44.6	15–23	3.9	15–19	None		50.5	0.9
23	Timothy	6.9	994	52.9	15–23	13.7	15–21	None		26.6	6.6
24	No cover crop	6.7	714	38.7	15–23	2.9	15–19	None		56.6	1.5

*April, 1925. **0.3 per cent (3.9 lbs.) overdamp.

MASSACHUSETTS

AGRICULTURAL EXPERIMENT STATION

BULLETIN No. 230 APRIL, 1926

RESEARCH SERVICE TO MASSACHUSETTS ANIMAL INDUSTRY

PROGRESS REPORTS

This bulletin contains five papers summarizing the experimental work of the Station which has to do with the feeding of farm animals. More complete reports of some of this work have been published in scientific journals. The subjects reported upon are as follows:

Mineral Matter for Dairy Cows — J. B. Lindsey and J. G. Archibald

Skim Milk Powders in the Rearing of Young Calves — J. B. Lindsey and J. G. Archibald

Better Feed from Permanent Pastures — Sidney B. Haskell

The Utilization of Feeds by Horses — J. B. Lindsey and J. G. Archibald

Improving the Feeding Value of Grain Hulls and Sawdust — J. G. Archibald

Requests for bulletins should be addressed to the

AGRICULTURAL EXPERIMENT STATION

AMHERST, MASS.

MINERAL MATTER FOR DAIRY COWS

By J. B. LINDSEY and J. G. ARCHIBALD

Introduction

It is a well-known fact that all animals require a certain amount of mineral matter in their diet. The fondness of all classes of stock for common salt is so well known that mention of it seems almost superfluous. The sight of a cow chewing a bone or an old shoe, licking the earth, or gnawing at a fence rail is familiar to anyone who has ever lived on a farm.

Until recent years, however, comparatively little attention has been paid to these outward evidences of mineral hunger, because of the belief that the feeds commonly fed to cows contained sufficient mineral matter (common salt excepted) for their needs. Gradually it has come to be realized that such is not always the case and that shortage of available mineral matter, under certain circumstances, may be a limiting factor in growth and production. The situation has been well summed up by the late Professor Armsby, who said: "Most feeding stuffs, and particularly the mixed rations of farm animals, contain what appear at first sight to be much larger amounts of ash ingredients than the body requires . . . . . This is doubtless true of animals living in a state of nature, but it is a questionable assumption under the artificial conditions to which many farm animals are subjected."

This point of view has become prevalent only within the past decade. Its establishment on a firm basis of fact has been due, in large measure, to the work done in recent years at certain of the experiment stations in this country. For example, it has been shown that in spite of liberal feeding, heavy milking cows excrete daily more mineral matter, particularly calcium and phosphorus, than they consume, or are in what is termed negative mineral balance, and it is only when they reach the advanced stages of lactation (10 pounds of milk daily) that the reverse is true; that is, that they consume more minerals than they give out. There is, however, no record of prolonged experiments on the effect of feeding mineral supplements to milking cows to help out a mineral deficiency. Realizing the dearth of such information and its importance, this department instituted such an experiment in the autumn of 1921, which, modified from time to time to meet changing conditions in the station herd, is still in progress. This paper is a brief report of the work up to October 1, 1925.

Plan of the Experiment

The main features of the experiment have been:

1. Feeding the whole herd a ration deficient according to prevailing standards in calcium and phosphorus but adequate in all other respects.

2. Division of the herd into halves as nearly alike as possible, and the addition to the grain ration of one group, of supplemental calcium and phosphorus in the form of special steamed bone meal containing but little animal matter.

3. Including in the experiment the heifer calves from the cows in the two groups and keeping them as far as possible on the same diet as their dams, in order to see if any effects of the treatment are more marked in the second or even in the third generation than in the original animals used.

4. Observation of the effects of the feeding upon:
   - (a) the general condition and weight of the animals,
   - (b) growth of heifers,
   - (c) milk production,
   - (d) composition of the milk, especially its content of calcium and phosphorus,
   - (e) reproduction, under which general heading have been observed:
     - (1) recurrence of heat,
     - (2) difficulties in getting cows bred,
     - (3) number of abortions and retained afterbirths,
     - (4) condition of the calves at birth and subsequently.

The Herd

The station herd is made up of high-grade Holsteins with a few Jerseys, and usually numbers, including young stock, eighteen to twenty head. At present there are nineteen animals included in the experiment,—fourteen milch cows, one two-year-old heifer, and three eight-months-old heifers.[1] There have of necessity been some changes in the herd since the experiment was started, but of the nineteen individuals originally included, ten are still in the herd. Since the commencement of the experiment in December, 1921, the milking herd has had an average annual production per cow of 8000 pounds of milk, testing 4.21 per cent of fat.

All cows are given a two months dry period during which time they are liberally fed, but they are not sent to pasture. They are maintained on dry feed the year around, except for a period commencing about June 25 and ending about October 10, during which time each cow is fed about 25 pounds daily of such green soiling crops as oats, millet, sorghum and fodder corn, as a substitute for a portion of their hay. Ensilage, roots or legume hay have not been fed during the experiment.

Rations Fed

The rations have purposely been made as poor in mineral matter as a wise choice of feeds, other factors being considered, would permit. The hay has consisted principally of timothy, with some red top, blue grass and orchard grass.

The grain ration has consisted of the following mixture:

	Per cent
Ground oats	39¼
Gluten meal	20
Red dog flour	20
Wheat bran	20
Salt	¾
	100

[1] All heifer calves are included in the experiment as soon as old enough to subsist on hay and dry grain. The age varies with the calf from five to seven months.

The mineral content of the entire ration was still further lessened by substituting for a portion of the hay, during certain periods of the experiment, such mineral-poor materials as chopped oat straw, starch, or apple pomace.

The whole herd has been fed as described above for four years, and in addition, one-half of the herd, known as the "bone meal" group, has received supplemental calcium and phosphorus in the form of steamed bone meal specially prepared for animal feeding. The bone meal was thoroughly mixed with the grain before feeding and the amount for each cow has varied with her weight and the amount of milk she gives, from three to eight ounces daily, the aim being to supply approximately a 60 per cent excess over the theoretical requirements of each cow. This excess is provided as a safeguard; for, although little is known about how completely mineral matter in the form of ground bone is utilized by the dairy cow, it is safe to assume that it is only partially digested and made available.

Results of the Experiment

General Condition and Weight of the Cows.

The condition of the animals has been carefully noted by means of observations made and recorded from month to month. At no time has it been possible to note any marked difference in the mature cows. Irrespective of the group in which they belong they have maintained themselves well. This has been especially true of the Holstein cows.

Among the young cows and heifers the effects of the low mineral ration have been much more apparent. Several of them are considerably undersized for their age, and present a general unthrifty appearance. Recently some of them have had very poor appetites, refusing at times both hay and grain. The young Jerseys seem to have been particularly susceptible, and while some of the Holsteins have also been affected they have stood up under the low mineral feeding better than the Jerseys. As with the aged cows the effects noted have been irrespective of whether they received bone meal or not, although recently there has been some evidence to favor the bone meal.

All of the cows that were mature at the commencement of the experiment have maintained their weights well, there being no significant variation from year to year in either group.

Growth of Heifers

Study of the growth records of the young stock in comparison with those of their dams shows that of twelve individuals, six are as large as their dams were at the same age and six are smaller than the dams were. These two groups are composed according to breed as follows:

Large as dam	*Smaller than dam*
Holstein—4	Holstein—3
Jersey—2	Jersey—3

According to grouping in the experiment they are divided thus:

Large as dam	*Smaller than dam*
Bone meal—3 (2H & 1J)	Bone meal—3 (1H & 2J)
No bone meal—3 (2H & 1J)	No bone meal—3 (2H & 1J)

So far, then, as growth records go the evidence is about evenly divided, there being nothing in favor of the bone meal.

Milk production

The milk yield has remained at a fairly constant average level all through the experiment. The average daily yield per cow from year to year is given below, *commencing two years before the experiment was started.*

Year	Average daily yield of milk per cow, lbs.
1920	21.87
1921	21.65
1922	22.67
1923	21.56
1924	21.06
1925	22.30

The above record is for the whole herd. Dividing the herd into the two groups, those that received bone meal and those that did not, we find the following records:

Year	Average daily yield of milk per cow, lbs.	
	"Bone Meal" Group	"No Bone Meal" Group
1922	22.20	23.13
1923	19.85	23.00
1924	21.36	20.76
1925	20.65	23.94

On this basis it would seem that the cows not receiving bone meal were the better producers. When we subjected our data to careful analysis, studying the records of the individual cows from year to year, and took into account the influence of breed, age, and length of lactation on the milk yield of the two groups, it was found that the evidence is not so favorable to the "no bone meal" group. In fact, it favors slightly the "bone meal" group of cows.

Composition of the Milk

The milk from each cow in the herd is sampled for five consecutive days each month. Total solids and fat have been determined in the composite samples each month during the course of the experiment. In addition the total ash, and calcium and phosphorus content of the milk have been determined from time to time,—on an average, about four times a year.

Average Composition of the Milk
since Commencement of the Mineral Experiment.*

(Expressed as percentages of the liquid milk)

	Whole Herd, (Dec. 1921-Oct. 1925)	"Bone Meal" Group.	"No Bone Meal" Group.
Total solids	12.74	12.83	12.67
Fat	4.21	4.27	4.16
Solids not fat	8.53	8.56	8.51
Total ash	0.724	0.722	0.725
Calcium (Ca)	0.117	0.118	0.117
Phosphorus (P)	0.096	0.093	0.098

* These figures have been corrected for differences in the relative number of Holsteins and Jerseys in each group, otherwise the much richer Jersey milk might give the figures a wrong significance. In the case of total ash, calcium and phosphorus, they have also been corrected for any influence that difference in stage of lactation of the cows in the two groups might have. It is well known that as a cow advances in lactation her milk becomes richer. This correction has not been necessary for the total solids and fat, as they have been determined regularly every month for all cows.

Effect on Reproduction

Recurrence of Heat.

Regarding regularity, the records show the following:

Regularity	Whole Herd	"Bone Meal" Group.	"No Bone Meal" Group
Good	15	7	8
Fair	4	3	1
Poor	0	0	0

The average length of time after calving before the first heat has been:

"Bone Meal" group,	37 days
"No Bone Meal" group,	39 days

The condensed data show that both groups were quite similar in their behavior in these respects. In fairness, however, it must be stated that as the experiment has progressed, the cows that received the bone meal have tended to come in heat sooner after calving, while the reverse has been true of those that did not receive bone meal.

Difficulties in Getting Cows Bred.

Considerable trouble has been experienced in getting the cows with calf, some of them needing the attention of a veterinarian, and having to be served four or five times before they would hold. Up until the past year or so the trouble became somewhat more prevalent as the experiment progressed. Since then, for some unaccountable reason, the cows have improved considerably in this respect. The groups have been quite evenly divided with respect to it, as the accompanying figures show.

Average Number of Times Bred.

Year	"Bone Meal" Group.	"No Bone Meal" Group.
1922	1.60	1.67
1923	2.25	2.67
1924	2.67	2.57
1925	1.60	1.50

Abortions and Retained Afterbirths.

There have been three cases of abortion and one premature birth in the herd since the commencement of the experiment. Two of the abortions were in the "bone meal" group, the other one and the premature birth were in the "no bone meal" group. Two of the abortions were caused by accidents and it is doubtful if the other two were due to the effect of the experiment. There have been six cases of retained afterbirth, of which four have been in the "no bone meal" group. This fact may be of some significance, or it may be mere chance.

Condition of the Calves at Birth and Subsequently.

All calves dropped during the course of the experiment have either been raised to maturity or kept a sufficiently long time to enable us to form an accurate opinion as to their constitutional vigor. The following table summarizes the records.

Condition of Calves.

Group and Year.	Vigorous.	Good.	Fair.	Delicate
Bone meal				
1922	1	1	...	1
1923	2	...	2	1
1924	1	2	2	..
1925 (to Oct. 1)	2	...	1	...
Total	**6**	**3**	**5**	**2**
No bone meal				
1922	1	1	2	2
1923	2	2	2	1
1924	2	1	1	2
1925 (to Oct. 1)	2	4	1	...
Total	**7**	**8**	**6**	**5**

The only result of any significance here is the somewhat higher number of delicate calves from the "no bone meal" cows. Proportionately the difference between the groups in this respect is not so great as a first glance at the figures seems to show, the ratio being roughly 3 to 2 instead of 5 to 2. Also the delicate calves have with one or two exceptions been from Jersey cows, so that it is probable that breed characteristics have had more influence than has the experimental treatment.

Summary

The object of the work reported here has been to ascertain what benefit may be derived from adding steamed bone meal, with the animal matter largely extracted, as a source of lime and phosphorus to the ration of dairy cows.

The entire herd has been fed for four years on a ration low in mineral matter, particularly in lime. One-half of the herd has had the deficiency made good in theory by adding bone meal to the grain.

The results in brief are as follows:

1. The experiment has had no appreciable effect on the general condition of the cows that were mature when it commenced. This has been especially true of the Holstein cows. The low mineral rations have adversely affected some of the young cows, as evidenced by their unthrifty appearance and poor appetite. The young Jerseys show this more than do the young Holsteins, although there are exceptions in both breeds. For a long time there seemed to be no difference in general condition between the "bone meal" and the "no bone meal" group; but recently there has been some slight evidence to favor the bone meal.

2. The mature cows have not shown any significant changes in weight, but about half of the young cows are smaller than their dams were at the same age. In this respect the evidence is about evenly divided, not favoring either group.

3. Milk production has been maintained well all through the experiment. The evidence on this point favors slightly the "bone meal" cows.

4. The composition of the milk has not been significantly affected.

5. The reproductive function has been more seriously disturbed than any other, considerable difficulty being experienced in getting the cows with calf. The two groups have been quite similar in this respect.

6. Each group has produced about the same proportion of strong, healthy calves. The "no bone meal" group has had a somewhat higher proportion of delicate calves, but this may have been due in part to breed characteristics.

Conclusions and Recommendations

Our work has led us to the conclusion that while dairy stock, especially growing heifers, must have an adequate supply of lime in their food in order to attain maximum development and productive capacity, the advantage to be gained from the practice of supplying lime in the form of steamed bone meal seemed to be very slight.

While we have still much to learn on the subject of mineral feeding of cows, the following recommendations are tentatively made:

1. Supply lime and other minerals in feeds that are naturally rich in ash, rather than by supplementing feeds low in ash with bone meal or other lime salts. All the leguminous hays are high in lime, in addition to their very desirable protein content. Alfalfa hay contains five times as much lime as does timothy hay. There is as much lime in a ton of red clover hay as in 100 pounds of ordinary bone meal, and it is in what is probably a more desirable form. It is in the choice of roughage that care must be used. The ordinary grains and concentrates are characterized by relatively low lime and

high phosphorus content, so that in so far as ash requirements are concerned it makes little difference what grain ration is fed.

2. All dairy cows should have a dry period of two months, during which time they should be liberally fed on a legume roughage, or on early cut hay containing clover, or on rowen, as well as on some grain to make up for the losses in mineral matter during the period of heavy milking. Good pasturage will also prove very satisfactory.

3. Growing heifers should receive special care with respect to the ash content of their rations. Here again some kind of properly cured legume or clover-mixed hay is the best safeguard.

4. Put the bone meal and other mineral substances on the land, rather than in the manger. Used in this way the yield and ash content of the crop are likely to be increased and thus indirectly the ash requirements of human beings and animals will be taken care of.

5. Common salt is the one exception to all the above statements. Animals should have free access to it at all times.

The above recommendations are what many successful dairymen now practice, and are within the reach of all who wish to improve their feeding practices in this respect.

NOTE: It is possible that most cows when fresh are in negative calcium balance; that is, they excrete in the milk and manure more calcium than they consume. This condition in all probability is more pronounced and continues for a longer period in case of cows bred for heavy milk production. It has been shown recently by the Wisconsin Station that direct sunlight checks this tendency to a limited extent. Whether the antirachitic vitamin is of pronounced influence in aiding calcium assimilation in case of dairy cows is still an open question.

SKIM MILK POWDERS IN THE REARING OF YOUNG CALVES

By J. B. LINDSEY and J. G. ARCHIBALD

In our studies of substitutes for whole or liquid skim milk in the rearing of young calves, we have tried both the drum dried and the spray dried skim milk powders.

Method of Manufacture of Milk Powders

In the spray process, the liquid milk is forced under high pressure through nozzles into the upper part of a heated chamber. The fine spray is dried to a fine powder by the time it reaches the bottom of the chamber. The chief advantage of this process is that the powder is very readily and completely soluble in water.

In the drum or roller process, the skim milk is fed from a gravity tank onto steam-heated rolls. It spreads out into a thin film, drying as the rolls slowly revolve. The dried film is removed from the rolls by scrapers, ground, sifted and packed. It is somewhat coarser in texture than the spray dried product and does not dissolve in water as readily. The manufacturers claim that the process is not destructive to the vitamins in the milk, especially Vitamin C.

Preparation of Skim Milk Powder for Feeding

One pound of the milk powder and a scant even teaspoonful of salt are added to each gallon of lukewarm water.[1] The milk powder and salt should first be stirred with a small quantity of cold water to avoid lumping, and after a creamy consistency has been secured, the necessary amount of lukewarm water added, the mixture well stirred and thus fed. Enough can be made up, if desired, to last twenty-four hours, but it should not be fed cold.

Method of Feeding

Whole milk was fed for the first week after weaning and then the skim milk solution gradually substituted. Not over nine quarts daily were fed to each calf and it is better, although not necessary, to continue feeding a minimum of two quarts of whole milk daily during the first six or eight weeks of the calf's life. After the first month, the calf was taught to eat rowen and a calf meal made up of 30 pounds red dog flour, 30 pounds ground oats, 15 pounds linseed meal, 24½ pounds of corn meal and ½ pound salt. By the time the calf reached four months of age it was eating one and one-half to two pounds of grain daily and a considerable amount of hay.

The experiment was ended when each calf reached the age of four months at which time the milk was gradually removed and dry feeds substituted. It is preferable, however, in case of promising dairy heifers, to continue giving some of the skim milk until the animals are five or six months of age, in order to promote rapid growth.

[1] If desired, one pound of the milk powder may be used to 5 quarts of water.

The Results

Relative Growth, Gains and Costs of Rearing Calves on Skim Milk Powders

Material	Number of Calves*	Average daily gain Lbs.	Dry matter required for 100 pounds gain Lbs.	Food cost per pound of gain Cents
Skim milk powder (drum process)	6	1.50	287.79	16.5
Skim milk powder (spray process)	6	1.39	277.72	22 2
Liquid skim milk for comparison	6	1.68	250.78	14.3

* All grade Holstein calves.

Liquid skim milk was charged at 1½ cents a quart, drum dried powder 7½ cents and spray dried powder 11 cents a pound (drum dried solution, 1.9 and spray dried solution, 2.75 cents a quart). The table shows:

1. That neither skim milk powder promoted as rapid growth as did the liquid skim milk.

2. That the drum process powder produced slightly better growth than did the spray process powder. The difference is not great and too much stress should not be placed upon it. Inasmuch, however, as the drum dried powder may often be purchased for several cents a pound less, it is to be preferred for calf feeding.

3. Dried skim milk offers the best substitute for liquid skim milk in the rearing of young calves. At the present, the price has advanced to 11 cents for the drum dried and 13½ per pound for the spray dried, which renders their use of doubtful economic value. The price will vary according to supply and demand.

BETTER FEED FROM PERMANENT PASTURES

By SIDNEY B. HASKELL

In the spring of 1921 the Massachusetts Experiment Station instituted certain fertilizer experiments on a typical, rock-bound, weed-grown permanent pasture. The pasture must have been last plowed more than 100 years ago, in the days of cheap labor and ox team power. A part of the pasture had once been tilled, had degenerated into pasture, had then grown a crop of wood and timber; and then after many years had been brought back to pasture in a century-long rotation. Of clover and blue grass there were but the scantiest traces. Running cinquefoil and great clumps of green moss had crowded out the better types of vegetation.

It was under these discouraging conditions that the first fertilizer was applied, as a top-dressing, in the early spring of 1921. A second, more elaborate experiment was started in 1922. The fertilizers applied, and the rates at which they were used, were as follows:

Acid phosphate,	480 and 960 pounds per acre.
Muriate of potash,	80 and 160 pounds per acre.
Ground limestone,	2400 pounds per acre.

Acid phosphate and muriate of potash as above, at the two different rates.

Space does not permit of extended description of the remarkable effect of these fertilizers. By 1923 many of the plots had developed a dense growth of white clover. Potash was the most effective of any of the treatments; lime and acid phosphate, used alone or together, were relatively ineffective. Potash and acid phosphate combined, especially when used in the limed areas, showed a distinct advantage over the potash alone. As time has elapsed, the apparent effectiveness of lime has been increasing; also, but to a less marked degree, has that of the acid phosphate.

Photographic records best portray the remarkable results of this experiment. A camera was suspended over a typical area, and in each of three successive years an exposure was made of the same portion of the sod. The upper picture shows the character of the sod as it was before fertilizer was applied; that in the center, taken a year later, shows the changing vegetation as produced by fertilizer; and the lower picture shows the results of 1923, which was definitely a "clover year." The fertilizer here used was the potash and acid phosphate mixture with lime. Similar results were obtained in the experimental plots started in 1922; but here, probably on account of more favorable weather conditions, the fertilizer had more rapid effect.

Effect of Fertilizer on Quality of Pasturage

About the middle of June, 1923, animals were barred for a three weeks period from the pasture plots fertilized in 1922. Samples of the three weeks' growth were cut, the product dried, weighed and subjected to chemical analysis. Results are shown in the following table:

Fertilizer Treatment	Dry Matter per Acre, Pounds	Protein	
		Per cent	Pounds per Acre
Acid phosphate 960 lbs.; no lime	863	14.17	122
Acid phosphate 960 lbs.; limestone 2400 lbs.	1050	18.70	196
Muriate of potash 160 lbs.; no lime	676	20.78	140
Muriate of potash 160 lbs.; limestone 2400 lbs.	1023	23.29	238
No fertilizer; no lime	703	14.60	103
Limestone 2400 lbs.	766	17.97	138
Acid phosphate 960 lbs.; muriate of potash 160 lbs.; no lime	1272	20.56	262
Acid phosphate 960 lbs.; muriate of potash 160 lbs.; limestone 2400 lbs.	1576	24.53	387

The greatly increased yield of protein on the best treated plot is most significant, with a total production equal to that contained in 2400 pounds of wheat bran. The cause of this change is of course the stimulation of clover and the suppression of the weeds brought about by the use of lime and fertilizer.

The Grass Cycle

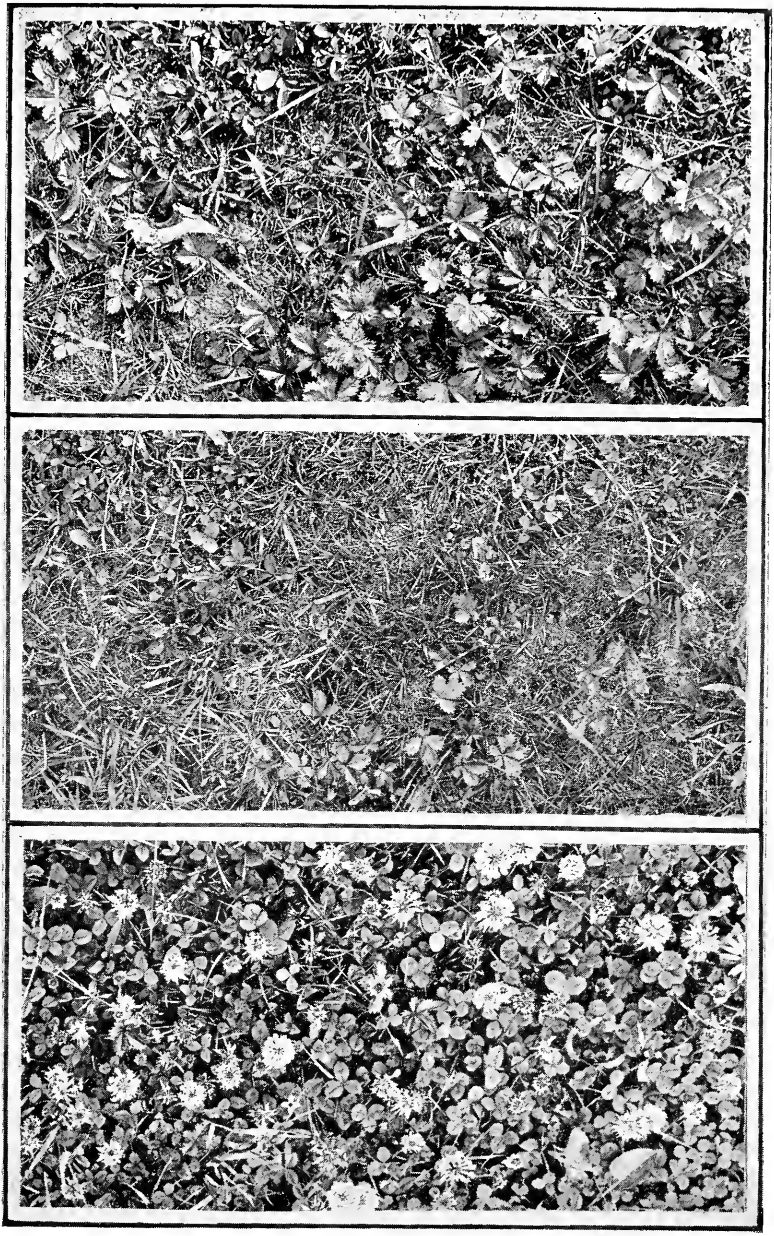
White clover, however, comes and goes. By the fall of 1924 it had disappeared from these plots almost absolutely and been replaced by blue grass. In the spring of 1925 no clover was in evidence, even on those plots which had been densely carpeted in the summer of 1923. In the early summer of 1925, however, drouth conditions prevailed, to be broken during the end of June by generous rains. These conditions favored clover, and by the end of that year it was once more dominant on all of the better fertilized areas.

It is impracticable to translate the above figures into terms of profit and loss. We have no means of knowing how long a time fertilizer will continue to show benefit. Yet the fact that large areas have already reverted to forest shows what must happen to existing pastures in case fertilizer be not applied; or in case the price of milk be too low to make profitable such fertilizer application.

What Fertilizers Are Needed.

On the relatively coarse grained, depleted granitic soils of the Station farm, potash was the plant food most needed. Best growth was obtained with lime. Acid phosphate applied in addition to lime and potash still further bettered the yield. The total expense of application of these three materials was, of course, very heavy. On heavier pasture soils, acid phosphate may be all that is required. In certain demonstrations west of the Connecticut River, instituted by the Department of Agronomy, M. A. C., this is indicated most clearly. It is probable that, where the soil is fairly close grained and has a favorable moisture supply, acid phosphate, with lime if the soil be extremely acid, will be all that is required. These of course must be applied as top dressing, which means that action is certain to be relatively slow.

The fertilizing of pastures is a most interesting field for farm experiments. There are, however, certain discouraging conditions attending it. Returns from fertilizer application are always delayed, for only by stimulating white clover and grass so that it can crowd out the weeds is the better pasture secured. If the weather be dry, there may be a period of weeks or even of months in which there will be no growth on either fertilized or unfertilized portions of the pasture. Even when good growth is produced, as should usually be the case, the fact may not be noticed, for increased forage may be pastured off as rapidly as it is grown. Yet with all of these uncertainties, the goal is worth the effort. A pasture which is in a weedy or run-down condition because of a lack of plant food can be brought back to productive condition only by the use of plant food.



Progressive Change in Pasture Vegetation.
Top—Before Fertilizer was Applied.
Center—One Year after Application.
Bottom—Two Years after Application.

THE UTILIZATION OF FEEDS BY HORSES

By J. B. LINDSEY AND J. G. ARCHIBALD

Although it is recognized that for many industrial purposes the automobile, auto truck and farm tractor have replaced the horse as a source of power, we believe that the horse, for a long time to come, will continue to have his place upon the farm and in certain other lines of industry.

For a number of years studies have been made at this Station of the digestibility, metabolizable energy and net energy of the ordinary roughages, grains and by-products likely to be fed to farm and other work horses in order to ascertain their relative nutritive values.

Units of Measurement.

In order to get at relative nutritive values, we must have one or more units of measurement. Obviously the foot rule or the yardstick would not serve for such a purpose. The best units we have are (a) chemical analysis of the feed, (b) its digestibility, (c) its total, metabolizable and net energy values.

(a) *Chemical analysis* tells how much of each of the several groups, protein, fat, carbohydrate and ash, a feed contains but it does not tell how much of each group the animal can finally utilize.

(b) *Digestibility.* By digestibility is meant the amount of each ingredient the animal can digest or so transform that it can be carried into the blood stream and made use of as food. The solid excreta or feces is the undigested portion of the feed which, subtracted from the total feed, leaves that which is digested. The *digestion coefficient* means simply the *percentage* of the feed or ingredient digested. Thus, if a feed contains 30 per cent or pounds of fiber in 100 pounds and 15 pounds is digested, the coefficient is 50.

(c) *Energy.* Every food may be regarded as a mass of latent energy. Digestion liberates this energy and the animal lives and produces, as a result of the liberation.

Total energy represents all of the energy contained in a feeding-stuff, and is determined by the use of a complicated piece of apparatus known as a bomb calorimeter

Metabolizable energy is the total energy less that contained in the feces and urine.

Net energy is the total energy minus that lost in the feces and urine and that used in the process of digestion and assimilation.

While the determination of digestibility tells us the amount of a food digested, it does not tell the cost to the animal of the energy expended in the digestive processes. Comparative digestibility of feedstuffs, however, is a very helpful unit of measurement, but net energy is the more exact. Unfortunately the present method for determining net energy is very difficult, expensive and time consuming. The only equipment available in the United States for large animals is that at the Institute of Animal Nutrition in Pennsylvania, financed by the National Government. The late Professor Armsby, the director of the institute, as a result of his own experiments and those conducted in Europe, deduced a formula for determining net energy, based upon chemical analysis, total energy and metabolizable energy. In the experiments here reported, we have made use of this formula after having determined the composition and the total and metabolizable energy in each feedstuff, as well as its digestibility; and it is these two units of measurement—*net energy*, expressed in therms[1], with *digestibility* as an aid— that we have used in getting at the relative values of the feeds studied.

Method of Procedure

Two horses were used in each trial. Each feed was analyzed and its total energy determined. Definite amounts daily were fed, the feces and urine collected, and the energy contained in them determined and subtracted from the total energy of the feed, which gives the metabolizable energy. By the application of the formula mentioned above, the net energy was estimated. In the above procedure we were able also to determine digestibility. Each actual experiment required about three weeks for its completion, in addition to a large amount of work in the chemical laboratory and in the calculation of the results.

Some Results of the Experiment

The Story of Alfalfa.

Two different lots of alfalfa were tested, one grown in New York state and the other on the Experiment Station grounds. The New York sample contained 11.7 per cent protein and 35.2 per cent fiber, while the Station sample contained 17.7 per cent protein and 27.5 per cent fiber. It is evident that the former sample was more mature than the latter.

Average Digestion Coefficients and Net Energy Values

Material	Digestion Coefficients (Per cent)				Net Energy per 100 pounds (Therms)
	Dry Matter	Protein	Fiber	Nitrogen-free Extract	
Alfalfa, New York sample	49	66	34	60	14
Alfalfa, Massachusetts sample	53	73	38	62	36
Alfalfa fed to cattle (for comparison)	58	72	46	66	34

These results indicate that the New York sample was more mature and less utilized by the horses than the Massachusetts sample; while the net energy values show that the horses had to expend considerably more energy to digest the New York, or late-cut sample.

The comparison of the digestibility of alfalfa by horses and cattle, given in the table, shows that cattle are able to digest alfalfa to a greater degree than are horses, although the protein is well and about equally digested by both classes of animals.

[1] The therm represents the amount of heat required to raise 1000 kilograms of water 1 degree Centigrade, and is used as a unit of measurement for energy.

What the Horses Did with Timothy and Kentucky Blue Grass Hay.

Five of the samples tested were largely Timothy, and contained from 3.86 to 7.68 per cent protein and from 28.9 to 31.7 per cent of fiber. It is evident that some samples were cut earlier than others. One sample was fine in quality, was composed mainly of Kentucky blue grass, and contained 7.70 per cent of protein and 28.35 per cent fiber.

The average digestion coefficients and net energy value are given in the following table:

Average Digestion Coefficients and Net Energy Values

Material	Number of Samples	Digestion Coefficients (Per cent)				Net Energy per 100 pounds (Therms)
		Dry Matter	Protein	Fiber	Nitrogen-free Extract	
Timothy Hay (coarse)	5	47	44	43	53	27
Kentucky Blue Grass (fine)	1	50	58	47	56	33
Timothy Hay fed to cattle (for comparison)	72	55	47	51	62	43

It was found that the total digestibility of the Timothy varied from 40 to 54 per cent, with an average of 47 per cent, and that the digestibility was inversely proportional to the fiber percentage; that is, the higher the percentage of fiber, the lower the digestibility. The net energy varied from 18 to 38 therms per 100 pounds, with an average of 27 therms. The sample containing the highest percentage of fiber, 31.68 per cent, contained but 18 therms of net energy per 100 pounds; while the lot which contained only 28.8 per cent fiber had 38 therms of net energy. The teaching is the same as in the case of alfalfa: namely, that late cutting, high fiber content and low net energy go hand in hand. The conclusion is clear, that the later the hay is cut, the less its nutritive value per pound or ton. Horse feeders prefer late-cut, coarse hay, not for its high nutritive value but because of its distention of the intestinal tract and its less laxative effect. They depend largely upon the grain ration for nutrition, and upon coarse hay as a distributor.

The fine hay was more digestible and had more therms of net energy than the coarse. The average results with cattle show that they are able to make better use of Timothy hay than do horses.

A Kansas Ration v. a Substitute Ration.

The Kansas ration, so-called, was a combination of alfalfa, corn and oats, recommended by the Kansas Experiment Station and the United States Department of Agriculture, who experimented jointly for a period of 140 days with 17 artillery horses, doing what was termed rapid light draft.

The combination which proved satisfactory in the trials cited was recommended on the ground that a relatively small amount of roughage (alfalfa) fed with a relatively large amount of corn and oats would require a minimum of energy for its digestion; and that the alfalfa furnished the necessary amount of protein and was not fed in sufficient amounts to prove injurious.

Inasmuch as alfalfa was but little grown in Massachusetts, we compared the Kansas ration with a substitute ration composed of Timothy hay, corn, oats, bran and dried brewers' grains, the latter furnishing the protein lacking in the Timothy.

The two combinations fed to determine digestibility and net energy requirements were as follows:

	Kansas Ration Lbs.	Substitute Ration Lbs.
Alfalfa	8.25	.....
Timothy	.....	9.00
Corn	6.60	4.20
Oats	1.65	2.40
Bran	.....	1.21
Brewers' grains	.....	1.80
Totals	16.50	18.61

Chemical Composition

Ration	Water as Fed (Per cent)	Dry Matter Basis					
		Ash (Per cent)	Protein (Per cent)	Fiber (Per cent)	Nitrogen-free Extract (Per cent)	Fat (Per cent)	Total Energy per 100 pounds (Therms)
Kansas	13.72	4.68	13.66	19.30	58.82	3.55	201.42
Substitute	11.42	4.55	11.91	21.56	58.17	3.80	203.84

In chemical composition one notices little difference except that the Kansas ration is lower in fiber and higher in protein.

Average Digestion Coefficients and Net Energy Values

Ration	Digestion Coefficients (Per cent)					Net Energy per 100 pounds (Therms)
	Dry Matter	Protein	Fiber	Nitrogen-free Extract	Fat	
Kansas	63	78	?	78	54	76
Substitute	53	65	?	64	35	59

The horses in each case digested little fiber and the results are not reported. A study of the digestion coefficients and net energy values shows that the horses made better use of the Kansas ration.

On the basis of 1000 pounds live weight, the horses in the experiments conducted at the Kansas station were fed, daily, 8.5 pounds of alfalfa, 6.8 pounds of corn and 1.7 pounds of oats while doing their work. These amounts seemed to us quite small, and practical experiments with our own horses, as well as comparisons with generally accepted standards, confirmed this conclusion.

As a result of our digestion and energy study, as well as of practical feeding trials, we have concluded that a combination of alfalfa, corn and oats in the proportions indicated above, known as the Kansas ration, proved superior to a combination of Timothy, corn, oats, bran and dried brewers' grains but that the amount of the Kansas ration fed per 1000 pounds live weight should be at least 20 per cent more than recommended by the original experimenters. The Kansas station emphasized the fact that alfalfa, when cut in full bloom and free from mold, smut and excessive dust, is suitable for horses; and that one and one-fifth pounds daily per 100 pounds live weight is the maximum amount to be fed to work horses.

Trials with the Cereals.

Experiments were made with whole corn, cornmeal, corn cobs, oats and oat hulls. Their chemical composition and total energy value are stated in the following table. For the sake of comparison the analyses are all stated on a dry matter (water free) basis.

Chemical Composition

Material	Water as Fed (Per cent)	Dry Matter Basis					
		Ash (Per cent)	Protein (Per cent)	Fiber (Per cent)	Nitrogen-free Extract (Per cent)	Fat (Per cent)	Total Energy per 100 pounds (Therms)
Corn meal	16.81	1.54	10.09	2.59	82.13	3.65	203.67
Corn, whole	13.40	1.38	9.88	3.05	81.58	4.13	199.58
Corn cobs	18.67	1.70	3.14	30.23	64.22	0.72	205.48
Oats, whole	10.97	3.35	13.38	10.39	67.56	5.32	207.75
Oat hulls	8.57	6.59	2.52	33.04	56.83	1.02	197.32

The cereals have about the same type of chemical composition; that is, they are relatively low in protein and high in carbohydrate or starchy matter. Oats contain more protein and fat and decidedly more fiber than corn. Corn cobs and oat hulls are quite deficient in protein and fat and are made up largely of fiber and of complex carbohydrates.

The results given below represent the averages secured with two horses.

Average Digestion Coefficients and Net Energy Values

Material	Digestion Coefficients (Per cent)					Net Energy per 100 pounds (Therms)
	Dry Matter	Protein	Fiber	Nitrogen-free Extract	Fat	
Corn meal	72	71	None	85	62	117
Corn, whole	74	62	None	85	51	113
Corn cobs	25	None	None	45	None	None
Oats, whole	61	75	None	72	57	118
Oat hulls	22	?	?	10	82	None

A little study of the figures in the table shows that the two horses digested the whole corn and corn meal in equal amounts and derived about the same net energy from them. One would suppose that corn meal would yield rather more net energy than whole corn because of the energy required for chewing the latter; but our method of measurement was not sufficiently sharp to detect the difference. Although the horses were able to digest 25 per cent of the corn cobs, they did not derive any net energy from them, all the energy being required for the efforts of digestion; hence we may conclude that the cob is without food value for horses.

Oats were not as well digested as corn, due to the presence of about 30 per cent of hulls, which were not digested by the horses in the present trial. Strange to say, the oats furnished fully as much net energy as the corn, namely 118 therms. This result is not confirmed by the few trials on record, which show 93 therms. A further study of the comparative net energy values of corn and oats for horses is desirable. Oat hulls were digested to about the same extent by horses as were corn cobs, and did not furnish any net energy. They are, therefore, without value as a source of nutrition for horses. The nutritive value of the oat for horses is contained in the groat.

Wheat Bran and Brewers' Dried Grains.

These materials are well known to all feeders. The question is often raised as to the value of wheat bran as a horse feed. Brewers' grains, both wet and dried, have been used with apparent success by many feeders of horses. The average chemical composition of the samples tested is stated below.

Chemical Composition

Material	Water as Fed (Per cent)	Dry Matter Basis					
		Ash (Per cent)	Protein (Per cent)	Fiber (Per cent)	Nitrogen-free Extract (Per cent)	Fat (Per cent)	Total Energy per 100 pounds (Therms)
Wheat bran	11.74	7.25	16.79	10.95	59.86	5.16	202.65
Brewers' grains	7.68	3.35	28.79	15.59	45.33	6.26	229.30

Both feeds contain a considerable amount of fiber. The brewers' grains are rich in protein and fat, the latter ingredient giving this feed its extra energy value.

Average Digestion Coefficients and Net Energy Values

Material	Digestion Coefficients (Per cent)					Net Energy per 100 pounds (Therms)
	Dry Matter	Protein	Fiber	Nitrogen-free Extract	Fat	
Wheat bran	52	83	None	61	None	52
Brewers' grains	51	77	27	50	46	?

The *average* digestion cofficients for the two feeds do not differ very much. The horses were able to digest about one-half of the entire dry matter, as against 62 and 66 per cent by bovines. The protein was well digested but the animals were unable to make much use of the fiber. The utilization of the fat in the present experiments seemed uncertain.

The ten single trials with wheat bran gave rather wide variations in coefficients as well as in net energy values which indicated that the horses experienced difficulty in making use of it. We are, therefore, led to conclude that as a source of nutrition, it is not to be recommended. It may be fed in limited amounts (1-2 pounds daily) as a component of a ration because of its gentle laxative effect.

The four digestion trials with brewers' grains gave reasonably uniform results. It was quite evident that the horses could digest the protein easily but had difficulty with the fiber. The variations in net energy value are so great that the average result is not stated. The reason for this is not apparent. While in many cases, depending upon local conditions and cost, brewers' dried grains may prove satisfactory as a component of the horse ration, it is believed they can be used to better advantage as a food for dairy stock.

The Utilization of Cottonseed Meal.

Two different lots were fed, testing as follows:

Chemical Composition

Material	Water as Fed (Per cent)	Dry Matter Basis					
		Ash (Per cent)	Protein (Per cent)	Fiber (Per cent)	Nitrogen-free Extract (Per cent)	Fat (Per cent)	Total Energy per 100 pounds (Therms)
Cottonseed meal, Lot I	7.62	7.10	37.51	19.69	28.04	7.66	224.53
Cottonseed meal, Lot II	8.76	6.68	41.27	12.79	31.22	8.01	225.44

The first lot of cottonseed meal was inferior to the second lot. It is evident that extra cottonseed hulls had been added to it, increasing the fiber to 19.69 per cent, much above the normal.

Digestion Coefficients and Net Energy Values

Material and Horse	Digestion Coefficients (Per cent)					Net Energy per 100 pounds (Therms)
	Dry Matter	Protein	Fiber	Nitrogen-free Extract	Fat	
Cottonseed meal						
Lot I						
Joe	61	84	23	71	90	61
Chub	71	89	65	58	100	87
Cottonseed meal						
Lot II						
Joe	62	87	38	36	87	73
Chub	69	84	19	62	93	104

It is hardly fair to average the two lots of meal, as one contains so much more fiber or hulls than the other. The horse Joe did not utilize the meal as well as did Chub. Both horses made excellent use of the protein and fat but failed to digest the fiber fully. Joe did not secure as much net energy as did Chub. It would be expected that Lot II, containing less fiber, would yield more net energy than Lot I, and such proved to be the case. On the basis of our results, exact figures for net energy cannot be deduced. It is believed that the data secured with Chub are more reliable than those secured with Joe. On this supposition it may be assumed that the therms of net energy in 100 pounds of cottonseed meal will be from 87 to 104. Much, however, depends upon the percentages of fiber and fat contained in the meal.

Our trials show that horses are able to digest cottonseed meal fairly well, especially the protein and fat; and that a liberal amount of energy was derived from its use,—nearly as much as from corn. Its chief use for the horse would be as a source of protein, especially for hard-worked horses, to the extent of from 5 to 10 per cent of the grain ration.

A Word About Linseed Meal.

Two experiments were carried out with this meal, but some of the results were so uncertain that they are not presented. The protein was quite as well digested as that contained in the cottonseed meal. The results for net energy varied widely. The writer would assume, however, that it would not vary greatly from those secured for cottonseed meal. Earlier feeding trials with linseed meal mixed with whole corn and oats, to the extent of 20 per cent, indicated that it did not mix evenly with uncrushed feeds. Horses do not care for it if fed unmixed, but will eat a reasonable amount readily if it constitutes part of a mixture. The addition of 5 to 10 per cent of linseed meal to a grain ration of one or more cereals will furnish the extra protein needed by hard-worked horses and will be eaten without trouble.

Percentage Energy Efficiency of Feeds for Horses.

The total energy contained in all feeds tested, expressed in therms, was 205.46 with extremes of 191 and 229, the latter figure being obtained from brewers' grains which contained considerable fat. The therms of total energy per 100 pounds of dry matter, for most cattle feeds, will not vary much from 200, except for those having more than the ordinary amount of fat.

The percentage of energy utilized—net energy—varied widely, from zero in case of corn cobs and oat hulls to 57 in case of corn. Two samples of alfalfa showed extremes of from 7 to 18 per cent of energy utilized, with an average of 13; six samples of Timothy hay from 9 to 19, with an average of 14. The amount of net energy and the percentage of energy utilized in coarse feeds depends evidently upon stage of growth. Corn was 57 per cent utilized, oats 57 per cent, cottonseed meal 36 per cent, and wheat bran 26 per cent.

We fail to find on record data of the utilization of energy of individual feeds by horses. It can be said, however, in general, that the less the percentage of crude fiber, and in roughages the less mature the material, the greater will be the energy available. Armsby has computed the availability of the energy for ruminants as varying between 5 and 24 per cent for roughages, 46 per cent for corn and hominy meals, and 29 per cent for wheat bran.

Summary

The results of the feeding trials with horses, reported in the preceding pages, may be summarized as follows:

Timothy hay and alfalfa had about the same net energy value, but different samples varied widely, depending upon the stage of growth.

Corn cobs and oat hulls were without net energy value.

The cereal grains had substantially the same net energy values—somewhat more than did the high-grade nitrogenous concentrates such as cottonseed and linseed meals.

Wheat bran had a low energy value and as a source of nutrition proved inferior to other concentrates fed.

The protein in dried brewers' grains was well utilized, but the results for net energy were uncertain. This material is recommended more as a feed for dairy stock than for horses.

Cottonseed and linseed meals have quite high net energy values and their protein is well utilized. They may serve in limited amounts (1 to 2 pounds daily) as a supplement to the grain ration for hard-worked horses.

The percentage energy utilization varied from 57 per cent in case of corn to zero in case of corn cobs and oat hulls; the energy in timothy hay and alfalfa hay was utilized to the extent of from 7 to 19 per cent with an average of 14 per cent.

The net energy value of feeds depends to a considerable extent upon the percentage of crude fiber present—the higher the percentage of fiber, the less the net energy and *vice versa*. In case of coarse feeds, the later the stage of growth and hence the more mature the material, the less its net energy value.

The *character* of fiber influences its digestibility and net energy value. Fiber in straw and oat hulls is less digestible than in corn bran and in early cut hay. The more mature a plant, the more woody the tissue becomes, with an increasingly lessened digestibility.

IMPROVING THE FEEDING VALUE OF GRAIN HULLS AND SAWDUST

By J. G. ARCHIBALD

Foreword

A great deal of study has been devoted by numerous investigators in different countries to improving the digestibility and consequently the feeding value of straws and other fibrous or woody materials. Straw of various kinds is only from 46 to 52 per cent digestible, oat hulls scarcely 40 per cent and cottonseed hulls 53 per cent digestible, while rice hulls, flax shives and sawdust show little if any digestibility. Furthermore, so much energy is required in the digestive processes that these materials, in their natural state, have but little net energy or actual nutritive value. Attempts to improve the feeding value by fine grinding, soaking in water and steaming under pressure have proved to be useless; so also has mixing the fine material with such a palatable substance as molasses.

The straws have also been treated with various chemicals such as dilute sulfuric and hydrochloric acids, lime in the form of the sulfide and oxide, sodium carbonate and sodium hydrate, both by boiling in open kettles and under pressure. Many of these methods have greatly improved the feeding value of the straws.

Why Wood, Straws, Grain Hulls and Similar Fibrous Materials Have Low Feeding Values.

Plant fibers (crude cellulose) are an aggregation of cell walls of certain specialized cells occurring in the plant. These cell walls become elaborated, enlarged and strengthened with age until maturity is reached, at which time, in high fiber plants at least, they constitute the major portion of the individual cells, the cell contents or protoplasm having been almost, if not altogether, absorbed or transported to the seeds.

In the early stages of growth, the cell wall consists of pure cellulose and hemi-cellulose and is soft and reasonably well digested, but as growth proceeds and maturity is reached, it becomes changed to a compound known as ligno-cellulose and the process is known as lignification. This ligno-cellulose complex cannot be digested to any extent because the digestive fluids cannot penetrate it. Some silicic acid also incrusts the complex and still further hinders the action of the digestive fluids and micro-organisms. The action of chemicals, particularly the alkalies, dissolves out the silicic acid and also breaks the bonds holding the cellulose and lignin together, and the cellulose thus set free can be acted upon and converted into nutritive material. As a result of the process, the lignin is more or less decomposed but is of little, if any, nutritive value.

Work at the Massachusetts Station.

Experiments with Oat, Barley, Cottonseed and Rice Hulls and Flax Shives.

The normal output of oat hulls by three of the leading oat-milling concerns in the United States has been estimated at over 100,000 tons. Data are not available for the other materials. Ground cottonseed hulls are added in limited amounts to cottonseed meal, and are also fed extensively in the South, unground and mixed with one-quarter their weight of cottonseed meal. Formerly, if not now, they were used as fuel in the cottonseed mills. Rice hulls and flax shives, ground fine, have been used in low-grade feeding stuffs or discarded by millers and farmers.

Any method which would bring about an increased digestibility of these, and similar by-products, was considered worthy of investigation. Aside also from the possible practical results, it was felt that the facts likely to be brought out would be of considerable scientific significance and open the way for further study.

Method Employed.

Originality is not claimed for the method used. It was devised by Dr. Ernst Beckman and employed by him and others during the World War for improving the value of different straws. Briefly stated, the method consisted in treating the hulls for three hours, with frequent stirring, with eight times their weight of dilute sodium hydrate (1.0, 1.5 or 3 per cent) after which the darkened soda liquor was allowed to drain off and the hulls thoroughly washed with cold water and dried.

Chemical Composition of the Untreated Hulls.

Material	Water as fed	Dry Matter (Per cent)				
		Ash	Crude protein	Crude fiber	Nitrogen-free extract	Crude fat
Oat hulls	7.70	6.33	2.26	33.24	57.24	0.93
Cottonseed hulls	6.93	2.13	4.08	43.99	48.60	1.19
Rice hulls	6.25	19.06	3.02	41.80	35.38	0.75
Flax shives .	6.78	4.09	5.24	53.81	35.05	1.81

The analyses show the several substances to be quite low in protein and fat and high in fiber. The cottonseed and rice hulls, and particularly the flax shives, are very fibrous in character. The character of the fiber governs to an extent digestibility, depending upon the exact nature of the linkage between the cellulose and lignin and possibly upon the chemical nature of the lignin.

The Action of the Soda (Sodium Hydrate) on the Hulls.

The above materials were treated with dilute sodium hydrate (1.5 per cent), as already described. The chemical dissolved out a little of the protein and fat and more of the nitrogen-free extract, the total losses varying from 10 pounds, in case of the cottonseed hulls, to 25 pounds, in case of the flax shives, for each 100 pounds of dry material treated. The nitrogen-free extract lost consisted principally of pentosans, substances similar to starch and cellulose.

Digestibility of the Treated Materials

After the treatment had been completed and the materials dried, experiments were carried out with sheep to determine digestibility.[1]

Summary of Digestion Coefficients.

	Total Dry Matter	Crude Fiber	Nitrogen-free Extract
Oat Hulls, untreated	36	52	34
Oat Hulls, treated	81	91	79
Percentage increase	**122**	**73**	**132**
Cottonseed Hulls, untreated	53	58	59
Cottonseed Hulls, treated	55	53	68
Percentage increase	**3**	**—10**	**15**
Rice Hulls, untreated	very little	very little	very little
Rice Hulls, treated	29	28	38
Flax Shives, untreated	0-30	0-19	4-33
Flax Shives, treated	29	23	38

The results in the above table represent the average for two sheep. The action of the soda solution is reported on the total material, designated as total dry matter, and on the crude fiber and nitrogen-free extract matter. The other ingredients (protein and fat) were present in such small amounts as to be without practical significance.

It is clear that the digestibility of the oat hulls as a whole (total dry matter) was very much improved, and the same can be said for the fiber and extract matter. The cottonseed hulls were not improved by the treatment. The sheep were not able to digest the untreated rice hulls to any appreciable extent, but did digest the treated hulls somewhat. The increase in digestibility was not sufficient to render the treated product of any practical value. The same can be said of the flax shives.[2]

On the basis of water free material (dry matter), after making an allowance for losses due to treatment, a ton of oat hulls was increased in digestibility from 725 pounds to 1345 pounds, the digestibility of the crude fiber from 349 to 732 pounds, and the nitrogen-free extract from 390 to 622 pounds.

It is evident, therefore, that as a result of chemical treatment,[3] a marked increase in nutritive value of the oat hulls has been secured and that such treatment would be of service in case of a pronounced shortage of cattle feed. Further study is warranted, in order to devise a method that will

[1] For description of method, see Mass. State Agr. Expt. Sta. Rept. 11, pp. 146-149, 1893; also Mass. Agri. Expt. Sta. Bul. 181.

[2] Barley hulls were also tested but they contained so much of the barley meal as to render the results valueless.

[3] A fuller report of these studies has been given in the Journal of Agricultural Research, Vol. XXVII, No. 5.

decrease the cost of treatment so that such materials could be handled economically in large amounts.

Work with Sawdust.

Sawdust from various woods has been proved to be without value as a food for domestic animals. Numerous investigations have been made and patents issued for the conversion of this inert material into a cattle food. The method of procedure in most cases has been the treatment of the sawdust with dilute mineral acids under pressure, or treatment with alternate portions of acid and alkali. These processes have resulted in converting more or less of the cellulose and hemi-celluloses into sugars. The cattle foods thus manufactured have not met with any extensive use, and so far as we are aware, are not at present on the market. Some time ago, the Forest Products Laboratory of the United States Department of Agriculture, located at Madison, Wisconsin, carried on extensive investigations in the conversion of the sawdust from several species of wood into more soluble forms, for the production of industrial alcohol and as a possible source of cattle food. The Forest Products Laboratory asked that the Massachusetts Experiment Station cooperate in making a study of the feeding value of the product. The material was prepared by them and shipped to this Station for study.

Method of Preparation.

The treatment consists in cooking the sawdust under 120 pounds pressure with dilute sulfuric acid (1.8 per cent) which converts a portion of the cellulose and allied substances into sugar. The liquor resulting from this treatment, together with water used in washing the residue, is neutralized with lime, and evaporated under reduced pressure to a thick syrup and then mixed with the previously dried residue. The product when ready for feeding is a dark brown, somewhat powdery meal, with a slight woody odor and a sweetish woody flavor. The materials sent were prepared from the sawdust of Douglas fir and white pine.

The work at this station consisted in the making of numerous analyses of the products, noting their palatability with dairy animals, determining their digestibility and noting their feeding value for milk production. We present below the results secured.

1. The treated or prepared sawdust is composed of crude cellulose and lignin together with some 28 per cent of sugars.

2. Animals will not eat the treated sawdust when fed by itself. In order to promote consumption it is necessary to mix it with other grains. Occasionally an animal will refuse to eat the mixture of which the sawdust is a component.

3. About 4 pounds daily is all that the mature dairy cow will consume, especially if it is fed for any length of time.

4. Digestion studies show that the dry matter of the Eastern white pine sawdust was about 46 per cent digestible, while that of the Douglas fir sawdust was about 33 per cent digestible. In the case of the Douglas fir sawdust, digestion was confined principally to the sugar formed by the treatment, while in the case of the white pine sawdust apparently some of the cellulose was digested also.

5. If the process of treatment could be modified so as to convert a larger proportion of the cellulose of the wood into sugar, or more completely separate the cellulose from the lignin, the food value of the material would be enhanced.

6. On the basis of equal amounts of digestible nutrients the sawdust when fed to dairy cows produced only slightly smaller amounts of milk than did corn starch, but it took, on an average, 2.75 pounds of sawdust to equal one pound of starch. The cows fed on the treated sawdust ration produced rather less milk, shown more in their milk yield at the beginning of the experiment, and gained less in body weight, on the treated sawdust than on the starch ration, all of which is indicative of the fact that, on the basis of equal amounts of digested matter, the treated sawdust was inferior to the starch.

7. On the basis of the present supply and cost of carbohydrate concentrates it is believed that the product as now prepared has no economic value. Under unusual conditions, as in the case of an extreme shortage of ordinary feedstuffs, it might be used as a partial substitute for the cereal grains or starchy by-products.

4,000. 5-'26. Order 5317.

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AGRICULTURAL EXPERIMENT STATION

TECHNICAL BULLETIN No. 7 MARCH, 1926

BROODINESS IN RELATION TO FECUNDITY IN THE DOMESTIC FOWL

By F. A. HAYS and RUBY SANBORN

This bulletin is the seventh in the series of bulletins reporting the investigations of the Massachusetts Agricultural Experiment Station on heredity in the Rhode Island Red breed of poultry; and the second giving report of the study on broodiness in the same breed. In addition there have been published at various times scientific papers presenting the results of certain more or less minor phases of this study.

Expressed in terms of change in the character of the breeding flock, the data show that the percentage of broody birds has decreased from 90 in the foundation flock of 1912 to 27 in 1923, the last year reported in this publication. Associated with this decrease in broodiness, the average annual egg production has increased from 114 to 200 eggs. The data show, however, that decrease in broodiness is but one of many factors which have contributed to increased production.

Requests for bulletins should be addressed to the
AGRICULTURAL EXPERIMENT STATION
AMHERST, MASS.

BROODINESS IN RELATION TO FECUNDITY IN THE DOMESTIC FOWL

By F. A. HAYS and RUBY SANBORN

Nature of Character Being Studied

Broodiness is the tendency of female birds to incubate or attempt to incubate eggs. The broody hen stays on the nest, clucks, ruffles feathers when disturbed, etc. It is a recurring cyclical trait in birds and should be considered as a normal phase of their reproductive process. It has no homologue in mammals since they reproduce viviparously (developed young). In reptiles, which are closely related to birds, we have oviparous reproduction, but the eggs are hatched without the attention of the mother.

All breeds of domestic chickens exhibit broodiness to some extent. The Asiatic or meat breeds are all intensely broody; the American breeds all exhibit the trait to a considerable extent; and the Mediterranean breeds, although said to be non-broody, always give some broody females.

There thus appear to be widely different degrees of broodiness. There have been birds in the Massachusetts Station flock that first showed broodiness in November of their pullet year and continued to exhibit its cyclical recurrence to the extent of ten or twelve times during the first laying year. Contrasted with this is hen C 960—non-broody during pullet year, twice broody the second year, and non-broody the third year. Also hen C 1347—non-broody as a pullet, broody once for 23 days her second year, and non-broody her third year. Hen C 4765 was broody once as a pullet for 17 days and non-broody her second year. On the other hand, we now have two hens (B 8450 and B 8797) that have completed four annual records without going broody. In general, three measures of broodiness may be used: namely, (1) the number of broody periods per year, (2) mean length of each broody period, and (3) total days of non-productiveness associated with broody periods. In all cases the length of a broody period has been taken as the period between last egg previous to going broody and first egg following "recovery."

Effect of Method of Handling

With the domestic fowl efforts are made to check the manifestation of broodiness so that the hen may begin laying again. Modern practice is to coop such hens in slat-bottom coops, making nesting almost impossible. After four to six days of such confinement, the bird may ordinarily be returned to the flock without resuming nesting. Such hens show wide diversity in length of time before resuming laying.

Trapnesting and regular removal of all eggs from the nests seem to "discourage" the onset of broodiness. Punnett reports two cases of hens from a broody-free race that were themselves non-broody for two years, later actually incubating and hatching eggs. This particular phase of the problem needs further elucidation.

Broodiness thus appears to be a normal phase of the reproduction of domestic chickens. Its occurrence seems to depend upon environmental and physiological stimuli as will be pointed out later.

Work Already Done.

By Other Investigators.

Bateson (1902) and Hurst (1905) both present data on crosses between broody and non-broody races, indicating that broodiness is a dominant character. No further information was obtained at that time.

Punnett and Bailey (1920) report some results using Black Langshans, Brown Leghorns and Gold-pencilled Hamburgs. Results:

Langshan ♀ x Leghorn ♂ gave all F_1* pullets broody. Of the F_2* generation 16 pullets were retained, 8 of which went broody as pullets. Punnett states that if the Langshans were of composition AABB and Leghorns aabb, F_2 should give 9 broody to 7 non-broody, a close approximation to actual ratio. The reciprocal cross, Leghorn ♀ x Langshan ♂ gave all broody in F_1, but in F_2 there were but 19 broody to 47 non-broody. Most of these birds were retained but one year. A few that were kept the second year added more broodiness so that the ratio is not 9 to 7, probably because of delayed appearance of broodiness.

In the Hamburg-Langshan cross, the F_1 hens were either non-broody or showed very little broodiness. Of 38 F_2 pullets, 4 were broody, 34 non-broody. These results suggest a third factor, N, which inhibits. F_1 birds would be NnAaCc, but factor N did not inhibit in all cases. The F_2 ratio gave 4 broody to 34 non-broody. Punnett states that his results are far from conclusive as to the true nature of the broody trait.

Pearl (1914) found much less broodiness in Barred Plymouth Rocks than exists in Reds. His method of measuring the intensity of broodiness was by the length of non-productive period. Other known factors, such as winter pause and molt make such a measure subject to error.

Work Done by the Massachusetts Station.

Goodale began the study of this trait in 1912. From that time up to 1921, when he severed his connections with the Station, very satisfactory progress was made in eliminating the tendency from the egg-laying strain of Rhode Island Reds.†

Recent Work at the Massachusetts Agricultural Experiment Station.

In the fall of 1922 the writer took up this project using the same general plan with some modifications. The non-broody strain has been carried along with the intense broody strain and not as a part of the general flock in so far as the matings are concerned. The non-broody birds are now being carried along through the second and third laying years to definitely test their behavior with regard to broodiness. Similarly, the breeding males are being carried over and tested for genetic composition. In a paper entitled, "Inbreeding the Rhode Island Red Fowl with Special Reference to Winter Egg Production," the broody trait has been shown to confirm Goodale's AC theory which suggests that broodiness is due to the presence of two dominant, autosomal, complementary genes, A and C. Both must be present to produce broodiness, but either may be carried alone by non-broody birds.

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* F_1 and F_2 refer to generations one and two.

† See Mass. Agri. Expt. Sta. Bulls. 199 and 211.

Progress to Date.

General Progress from Year to Year.

Table 1.—Mean Degree of Broodiness by Years.

Year Hatched	Birds broody, per cent	Average number of broody periods per broody hen	Total number of birds available*	Annual Production
1912	89.60	4.4	125	114
1913	91.03	5.4	78	124
1914	85.95	4.3	121	103
1915	89.25	4.3	428	122
1916	86.31	3.5	431	134
1917	48.84	2.7	432	166
1918	61.40	2.9	215	169
1919	No annual records			
1920	46.03	2.9	126	200
1921	44.56	2.7	285	200
1922	28.91	1.9	399	200
1923	27.35	1.9	340	189

* This column includes all Rhode Island Reds except intense broodies and inbreds.

It will be observed that the percentage of broody birds has been reduced from 90 in 1912 to 27 in 1923. Great significance should also be attached to the fact that the mean annual egg yield has increased from 114 to 200 in the same period. In the 1912 flock each broody hen lost 75 days in broodiness her first year, while in the 1922 flock each broody hen lost but 29 days. The assumption seems justified, therefore, that progress in eliminating broodiness has been two-fold: namely, reduction in the percentage of broody birds, and reduction in the mean degree of broodiness.

The average number of days spent in broodiness for the 112 broody birds in the 1912 flock is 74.8. For the 71 broody birds in the 1913 flock the figure is 78 8 days. In the 1922 flock, made up of all birds except those bred for intense broodiness, there were 112 birds that were broody, with a mean of 28.71 days spent in broodiness. In the 1922 flock there were 33 birds bred for intense broodiness. These birds averaged 42.94 days broody for the pullet year.

Specific Results.

The non-broody strain has been strengthened during the past two years by the retention of non-broody hens up to five years old. Such hens have been used as breeders each season so that their genetic character for broodiness may be confirmed by the progeny test. Aged breeding males have also been retained for similar purposes.

An intense broody strain has been carried on from year to year. Females selected to perpetuate this strain have been selected with a view of combining the maximum number of broody periods with desirable traits from the standpoint of annual fecundity. This intense broody strain will eventually differ from the non-broody strain only in possessing the broody trait. It is possible in this manner to measure directly the effect of broodiness on fecundity. This intense broody strain differs from the foundation birds more in the distribution of broody periods throughout the laying year than in the number of broody periods.

Complete records of broodiness are also maintained on every female of the experimental flock to augment data collected in the broody experiment.

End to Be Attained

A flock of poultry breeding *true* for broodiness and non-broodiness.

Scope of This Report.

In this bulletin consideration is given to the actual relationship between pullet-year egg production and the broody trait as manifested during the first laying year. Coefficients of correlation have been calculated as follows:

Between broodiness and rate.
December rate—Sections 1, 2, 3, 4, 5, 16, 17.
Winter rate—Sections 6, 7, 8, 9, 10, 18, 19.
Annual rate—Sections 11, 12, 13, 14, 15, 20, 21.

Between times broody and length of broody periods.
Section 22.

Between winter rate and annual rate.
Section 23.

Between winter rate and annual egg yield.
Section 27.

Between annual rate and annual egg yield.
Section 28.

Between broodiness and egg yield.
Winter production—Sections 24, 25, 26.
Annual production—Sections 29, 30, 31, 32, 33, 34, 35.

Coefficient of Correlation.

The coefficient of correlation furnishes a concrete measure of the tendency of two characteristics to move together, to move in opposite directions, or to behave independently. In this particular study the characteristics studied both belong to the same individual fowl. Either a significant positive or negative correlation coefficient is useful to the breeder as a guide, and the magnitude of the coefficient shows him the relative amount of dependence between the traits or characters considered. The value of a coefficient of correlation from the biological standpoint depends upon its absolute magnitude and upon its relation to its probable error. A coefficient at least three times as great as its probable error is generally considered significant, even though its absolute magnitude is small. The deductions reported in this bulletin are based on the above conception. King (1923), however, states that the correlation coefficient should be more than six times its probable error. He further states that a correlation coefficient of less than .30 indicates a lack of marked correlation, that over .50 shows decided correlation. Furthermore, the correlation coefficient with its regression coefficients may be used for purposes of prediction. The value of a knowledge of the degree of correlation lies mainly in its use for selecting a group of breeders and not in the selection of individual breeders.

The true coefficient of correlation may only be calculated for a race pure with regard to the characteristics being studied, as Harris (1915) points out. False correlations result when two or more genetically different races are concerned in any calculation. Broody birds have been shown to be genetically different (Hays, 1924) from non-broody birds. In studying the relation of broodiness to fecundity, it has been deemed advisable to make three general groupings: namely, (1) total population of broody and non-broody combined, (2) only birds that went broody during the pullet year, and (3) broody or non-broody without regard to the degree of broodiness. The first series of calculations was made for two purposes: first, to confirm that broody and non-broody races are genetically different; second, to furnish evidence on the intensity characteristics in relation to the broody trait even in a mixed population of broodies and non-broodies. The third series of calculations was made by Yule's formula for presence and absence of a character, as given by Davenport (1907). All other calculations were made by the ordinary method for calculating the correlation coefficient for fluctuating variables.

The regression coefficient is readily calculated after the correlation coefficient is determined. It is useful to the breeder for selection purposes. If a group of hens, each five times broody, were selected, the regression coefficient might be used to estimate its probable average egg production. If the degree of correlation between days broody and annual production is known, it is a simple matter to calculate the probable annual egg record of hens broody for 25 days or for any other period of days. Thus the regression coefficient merely represents the amount of change in one character with respect to a unit change in another. For example, the regression coefficient of days broody on annual production is —.1171, and the regression of annual production on days broody is —.3295. What should be the average annual egg yield of hens broody for thirty days?

42.87 average days broody of all hens
30.00

—12.87 days broody below the average
—12.87 x —.3295 = 4.2407 + 164.885 (average production of all) =

169.1257, probable record of hens broody for 30 days

The correlation ratio is comparable to the correlation coefficient and has a similar use. The former is made use of where the correlation coefficient would be false. As a measure of association in mixed races the correlation ratio is reasonably accurate, but it is of less value than the correlation coefficient for prediction purposes. Since a constant is calculated for each of the two variables in correlation ratio, a difference in magnitude of these two constants sometimes occurs, probably due to genetic impurity. Correlation ratio has not been used extensively in these studies because the correlation coefficient has been calculated on the three classes of hens with respect to broodiness: namely, broody and non-broody, different degrees of broody, and broody or non-broody, so that regressions closely approach linearity.

Character of Birds Used.

Beginning in the spring of 1916 the plan of breeding Rhode Island Reds for high egg production was somewhat modified. On that year matings were planned to consider early sexual maturity, no winter pause, intensity, persistency, and especially non-broodiness. Particular attention was given to the elimination of the broody tendency by using females non-broody during the pullet year and males from non-broody mothers for breeding purposes. The original foundation stock was all standard-bred Rhode Island Red. No new blood has been introduced into the flock since the plan of mating for the five characteristics above referred to was inaugurated in 1916. Inbreeding has not been practiced to any considerable extent, but the line of ancestry has been markedly reduced so that the present flock traces to but a small number of the best foundation birds.

Records Kept

Records used in the study of broodiness include complete pedigree of all birds used; complete trapnest records of every female as long as retained; date hatched; date of first egg; age at first egg; weight at first egg; nesting records; date of appearance of broodiness; date of placing into broody coop; date of return to laying house; hatching record of females used as breeders; complete family record of the progeny from each mating; and daily, winter and annual records on all surviving females.

Intensity.

Intensity and rate are terms used interchangeably in this report. They refer to the number of eggs laid in a specific interval of time on a percentage basis of the maximum possible number of eggs in the time considered. *December Rate*, as used here, is a figure obtained by dividing the number of eggs laid by 31 if the hen began laying on or before December first. For birds that laid their first egg later than December first, the rate was calculated by dividing the number of December eggs by the number of days *from first egg* to the end of December. As a short-time measure of intensity this may be considered more accurate than the actual number of eggs laid during December, for obvious reasons. *Winter Rate* is calculated by dividing the total number of eggs from first egg to March first by the number of days from first egg to March first, less all pauses of four or more days in duration from November first to March first. *Annual Rate* is calculated by dividing the total eggs from first egg to 364 days thereafter, for all birds that showed no 30-day pause after March first, by the number of days from first to last egg. When a bird stopped laying for thirty or more days after March first, her laying year is assumed to terminate at the beginning of this pause, and her annual rate is calculated by dividing the number of eggs laid by the number of laying days before the pause.

Broodiness.

Broodiness has already been defined as the tendency of the female fowl to incubate or attempt to incubate eggs. The intensity of broodiness may be measured by the number of broody periods and by the mean length of broody periods. Both Pearl (1914) and Goodale (1920) have measured the length of each broody period by the cessation of egg production associated therewith. Goodale (loc. cit.), however, stresses the fact that winter pause and fall molt may prolong the non-productive period for a considerable time interval beyond the normal broody period.

In the present studies, the observation has been made that there is a remarkable degree of uniformity in length of broody periods in the same individual. In the occasional bird that goes broody during the fall or winter of her pullet year, the winter pause may greatly lengthen the period of non-production. In such cases we have allowed four days for the bird to begin laying after removal from the broody coop to the laying house. Such birds are removed from the broody coop only when they no longer show signs of broodiness. In such cases any pause up to March first, of greater duration than four days following removal of hen from broody coop to laying house, is not considered a broody pause.

Very frequently the laying year terminates with a broody period and no more eggs are laid for two or three months. In such cases the length of the last broody period is calculated in the same manner as outlined above for the winter season. This long period of non-production is without question due largely to the onset of complete molt and not to broodiness. The fact that non-broody birds exhibit this long period of non-production during molt is very convincing evidence on the point in question.

Relation of Broodiness to Fecundity.

In studying the relation of broodiness to fecundity, it has been necessary to study the degree of correlation between broodiness and rate of laying, times broody and mean length of broody periods, winter rate and annual rate, winter rate and annual egg yield, annual rate and annual egg yield, and broodiness and annual egg yield.

Unpublished data at this Station indicate that rate of laying or intensity is the most important single characteristic affecting egg yield. For this reason, the relation between broodiness and rate is of extreme importance. Either a positive or negative correlation between broodiness and rate would be far more significant genetically than would the absolute correlation between broodiness and egg production; for egg production has already been shown by Goodale and Sanborn (1922) to depend upon at least five characteristics and one of these characteristics is rate. In the present study of the relation of broodiness to fecundity these facts are fully considered.

1. *Correlation Between Times Broody and December Rate—Pullet Year.*

In this study pullets are included that were hatched on the following years: 1916, 1917, 1918, 1920, 1921, 1922 and 1923. The flock hatched in 1919 is not included because no annual records are available for that year on account of a disease epidemic. All Rhode Island Red pullets with normal records are included. In addition to the major portion of each flock that was bred for egg production, there are included a small number of inbred birds, a small number bred for intense broodiness, a small number bred for color, and a small number used in studying the inheritance of hatchability. Inasmuch as this report is a study of the relationship between broodiness and fecundity, there is no conceivable reason why a rather heterogeneous flock should not be as valuable for study as one of marked uniformity for all characteristics.

Some short-time record of production is often made use of by commercial poultrymen in predicting the laying ability of a pullet for the year. Winter pause is likely to appear in many birds during December and is very pronounced in earlier birds. Other birds beginning their laying year early and continuing to lay regularly through December, as well as those starting their laying year in December, will as a rule have high December rate. Possibly November records would be freer from the winter pause, but such records would be less valuable than December records for predicting either winter or annual egg records, as Harris and Goodale (1922) have shown. It therefore seems advisable to use December rate in studying the relation of broodiness to rate.

A total of 1945 birds consisting of both broody and non-broody are included in the study. The range in times broody is from 0 to 12, divided into 13 classes. The range in December rate is from 1 to 100, divided into five-unit classes. Constants calculated from this study follow:

Number of birds	1945
Mean times broody	1.41
Times broody standard deviation . . .	±1.98
Mean December rate	59.60
December rate standard deviation . . .	±20.40
Coefficient of correlation	+.0639 ± .0152

The constants given above impress the reader with the marked variability in the birds studied, both with regard to times broody the first year and December rate of production. The apparently abnormal standard deviation in times broody is due to the large percentage of non-broody birds (51.23 per cent). In other words, an impure population is concerned.

The magnitude of the standard deviation in December rate signifies very marked variation in rate of laying for December. Even such a short-time measure of fecundity is subject to excessive variability.

The coefficient of correlation between times broody and December rate, although more than three times as great as its probable error, is of questionable magnitude and is a false correlation as Section 2 shows.

2. Correlation Between Times Broody and December Rate for Broody Birds Alone—Pullet Year.

In order to measure the relation of degree of broodiness, as indicated by the number of periods, to December intensity, only birds actually going broody have been used in the calculation of the correlation coefficient. Of the group of 1945 individuals studied in section 1, 949 birds actually went broody during the pullet year. This number has been used to study the relation of degree of broodiness to December rate. Constants arrived at follow:

Number of birds	949
Mean times broody	2.89
Times broody standard deviation . . .	±1.95
Mean December rate	61.24
December rate standard deviation . . .	±20.11
Coefficient of correlation	+.0145 ± .0219
Regression broodiness on rate	+.0014
Regression rate on broodiness	+.1498

The very large standard deviation in times broody suggests a most pronounced variability in number of broody periods. The actual range is from 1 to 12. Since the modal class is broody but once, there can be but little further progress in reducing the mean number of broody periods within the broody race.

The mean December rate is slightly higher than that for both broodies and non-broodies combined, in section 1. The standard deviation in rate is of the same magnitude as that in section 1.

The coefficient of correlation between degree of broodiness and December rate is actually less than its probable error, and since it is of very small magnitude, the interpretation seems justified that December rate is independent of degree of broodiness, and that the correlation in section 1 is false.

3. Correlation between the Presence of Broodiness and December Rate above the Mean of Broodies and Non-broodies Combined—Pullet Year.

The actual correlation between the presence of broodiness and high rate is of much importance to the breeder. Such a constant was calculated for the 1945 broody and non-broody birds by the method of Yule (loc. cit.).

December Rate	Broody	Non-Broody
Number above population mean	632	595
Number below population mean	317	401
Totals	949	996

Coefficient of correlation $+.1466 \pm .0150$

Although the degree of correlation between the presence of broodiness and high December rate is not large, there can be no justification for any other deduction than that the presence of broodiness is partially linked with high December intensity. The elimination of the broody trait should result in something of a reduction in December rate for the flock as a whole.

A further consideration of this relationship in a flock high in broodiness and in a flock low in broodiness seems advisable. The 1916 flock showed 86.31 per cent broody and is unimproved, at least for broodiness. The 1923 flock showed 27.35 per cent broody and may be classified as an improved flock.

4. Correlation Between the Presence of Broodiness and December Rate above the Mean of Broodies and Non-broodies Combined—Pullet Year (Unimproved Flock 1916).

In the total of 253 birds the following results were obtained:—

December Rate	Broody	Non-Broody
Number above population mean	138	14
Number below population mean	85	16
Totals	223	30

Coefficient of correlation $+.2996 \pm .0386$

The above constant suggests that in the 1916 flock there was a rather distinct tendency for broody birds to lay at a higher rate during December than non-broody birds. The constant given in section 3 for the entire period reported upon is $+.1466 \pm .0150$. A comparison of the two constants assigns them a similar value in comparison with their probable error, as each is about eight times its probable error. There is the possibility that December rate is higher in the early flock because they were slow to reach sexual maturity, so that winter pause was less pronounced in December than in later flocks.

5. *Correlation Between the Presence of Broodiness and December Rate above the Mean of Broodies and Non-Broodies Combined—Pullet Year (Improved Flock 1923).*

A total of 404 birds is studied in the 1923 flock, distributed as below:—

December Rate	Broody	Non-Broody
Number above population mean	78	157
Number below population mean	51	118
Totals	129	275

Coefficient of correlation $+.0695 \pm .0334$

The degree of correlation amounts to insignificance compared with its probable error. It indicates no dependence between the presence of broodiness and December rate above the mean. It is conceivable that early maturity may affect December rate, and winter pause is more pronounced in the flocks since the age at maturity has been reduced.

6. *Correlation Between Times Broody and Winter Rate—Pullet Year.*

This study included 2221 pullets hatched the same seven years as those studied for December rate. Winter rate is calculated on the period from first egg to March first, as already explained. Unpublished data at this Station indicate a rather intimate correlation between winter rate and annual production. Winter rate was calculated on a greater number of pullets than were studied for December rate, because the latter could only be calculated on individuals laying one or more eggs in December. The same classes were used in tabulating times broody and winter rate as were used in studying December rate. Constants calculated are as follows:—

Number of birds	2221
Mean times broody	1.43
Times broody standard deviation . . .	±1.99
Mean winter rate	66.45
Winter rate standard deviation	±9.37
Coefficient of correlation	+.0706 ± .0142

The above constants show the mean winter rate to be greater than the mean December rate previously calculated. The above winter rate really signifies that, on the average, the birds laid 66.45 per cent of the maximum possible number of eggs when they were laying, since all pauses of four or more days have been deducted in calculating winter rate. The standard deviation in winter rate is only ± 9.37 compared with a figure of ± 20.40 for December rate. The winter pause and the fact that many of the birds actually lay their first egg during December account for the wider variability in December rate.

The coefficient of correlation between times broody and winter rate is almost identical with that between times broody and December rate. This is a constant of small magnitude, and is a false correlation because the population is made up of both broody and non-broody birds.

7. Correlation Between Times Broody and Winter Rate for Broody Birds Alone—Pullet Year.

In order to ascertain any possible relationship between winter rate and degree of broodiness, the correlation between times broody and winter rate has been calculated for broody birds alone. The constants obtained are as follows:—

Number of birds	1098
Mean times broody	2.89
Times broody standard deviation	±1.93
Mean winter rate	67.57
Winter rate standard deviation	±9.63
Coefficient of correlation	—.0314 ± .0203
Regression broodiness on rate	—.0063
Regression rate on broodiness	—.1564

The mean winter rate in those birds that actually went broody during their pullet year is 67.57 compared with 66.45 for broodies and non-broodies combined. Such a difference is of no significance.

The coefficient of correlation is negative. Its small magnitude, together with the size of its probable error, leads to the assumption that there is absolute independence between winter rate and degree of broodiness as measured by times broody.

8. Correlation Between the Presence of Broodiness and Winter Rate above the Mean of Broodies and Non-Broodies Combined—Pullet Year.

The absolute correlation between the presence of broodiness and high rate is of importance to the breeder. Such a constant will indicate whether or not the broody trait carries with it higher winter intensity than does the non-broody trait. The coefficient of correlation is calculated below according to Yule.

Winter Rate	Broody	Non-Broody
Number above population mean	674	558
Number below population mean	422	565
Totals	1096	1123

Coefficient of correlation $+.2358 \pm .0135$

The magnitude of the above constant points to a linkage between broodiness and high winter intensity. Herein lies a probable explanation why the heavier breeds, all of which carry the broody trait, are in general superior winter layers to the non-broody lighter breeds. In the history of the flock under consideration, the highest average winter records, 67.65 and 74.5 eggs, were made by the 1920 and 1921 flocks with a percentage of broodiness amounting to 46.03 and 44.56 respectively of birds included. The 1923 flock, for example, showed 27.35 per cent broody and a mean winter egg record of but 51.04. Probably broody birds carrying early sexual maturity and no winter pause are superior as winter layers to non-broody birds possessing the same two traits, because of some linkage between broodiness and high intensity. Further consideration is given to this important question in sections 9 and 10.

9. Correlation Between the Presence of Broodiness and Winter Rate above the Mean of Broodies and Non-broodies Combined—Pullet Year (Unimproved Flock 1916).

Winter rate and broody records are complete for 332 birds in the 1916 flock. These have been correlated below:

Winter Rate	Broody	Non-Broody
Number above population mean	174	15
Number below population mean	115	28
Totals	289	43

Coefficient of correlation $+.4770 \pm .0286$

This is a rather pronounced correlation and shows winter intensity was associated with broodiness in an early flock.

10. Correlation Between the Presence of Broodiness and Winter Rate above the Mean of Broodies and Non-Broodies Combined—Pullet Year (Improved Flock 1923).

Winter rate and broody records for 430 birds hatched in 1923 are tabulated below:

Winter Rate	Broody	Non-Broody
Number above population mean	87	141
Number below population mean	51	151
Totals	138	292

Coefficient of correlation $+.2925 \pm .0297$

A significant coefficient of correlation between broodiness and high winter rate suggests that there is linkage between broodiness and high winter intensity. Further evidence has already been presented in sections 8 and 9. Herein lies the probable superiority of broody breeds over non-broody breeds in winter intensity.

11. Correlation Between Times Broody and Annual Rate—Pullet Year.

The method used in calculating annual rate does not allow for winter pause or for time lost while broody. It is simply a figure intended to measure the actual rate of laying between the time of laying the first pullet egg, and time of laying the last egg before the complete molt. Winter pause birds and broody birds are actually penalized in calculating annual rate. If there is absolute independence between broodiness and winter pause, the only normal handicap that the broody bird carries over the non-broody is the production loss during broody periods. Inasmuch as the magnitude of the annual rate depends most largely upon yearly egg production, this method of measuring rate should be most significant in breeding for fecundity. It is believed that this is a true measure of actual rate of laying during the year. Constants calculated from the 2245 individuals studied follow:—

Number of birds	2245
Mean times broody	1.44
Times broody standard deviation	± 1.98
Mean annual rate	56.48
Annual rate standard deviation	± 9.85
Coefficient of correlation	$-.2620 \pm .0133$

The above constants show that the 2245 birds actually laid on 56.48 per cent of the possible days between their first egg and the time they ended their year with the complete molt. The standard deviation agrees closely with that for the winter rate. A mean rate of such a magnitude immediately suggests high annual production.

The coefficient of correlation between times broody and annual rate is negative; and its magnitude, together with its small probable error, suggests that broodiness and low rate tend to move together.

By the use of the regression coefficient we find that those birds with a mean rate of 60.48 will be less broody than the mean of all birds studied ($1.44 - .21 = 1.23$). The fact is very evident, therefore, that broodiness tends to lower annual rate of laying. The coefficient as determined, however, does not represent the true correlation, since the flock of 2245 birds is made up of both broody and non-broody races.

12. Correlation Between Times Broody and Annual Rate for Broody Birds Alone—Pullet Year.

A pure race in so far as the broody trait is concerned is to be found in the birds actually going broody during their first laying year. The total number of birds in this class for the seven years is 1122. By tabulating the annual rate of each individual against her number of broody periods a measure of the degree of correlation between degree of broodiness and annual rate is obtained. Constants calculated on this group follow:—

Number of birds	1122
Mean times broody	2.89
Times broody standard deviation	±1.91
Mean annual rate	54.93
Annual rate standard deviation	±9.24
Coefficient of correlation	—.3232 ± .0180
Regression broodiness on rate	—.0669
Regression rate on broodiness	—1.5610

The mean annual rate for the broody birds is slightly lower than was found for the total population in section 11 (56.48). No significant change is observable in standard deviation.

The coefficient of correlation is slightly larger than that obtained for the total number of birds, and represents a rather intimate negative correlation between times broody and annual rate. Degree of broodiness as measured by number of periods is therefore very inimical to high annual rate.

13. Correlation Between the Presence of Broodiness and Annual Rate above the Mean of Broodies and Non-broodies Combined—Pullet Year (Flocks 1916-1923).

The true relation or correlation between the presence of broodiness and annual rate above the mean is of interest and value to poultrymen. Such a determination has been made for the 2245 birds being studied, by Yule's method.

Annual Rate	Broody	Non-Broody
Number above population mean	513	675
Number below population mean	609	448
Totals	1122	1123

Coefficient of correlation —.2828 ± .0131

The above constant does not differ significantly from that representing the whole population. In this particular case the mingling of a broody and a non-broody race in the same correlation table did not result in skew correlation. The constant —.2828 ± .0131 is known to represent a true value for the flock in question, and emphasizes the importance of breeding for non-broodiness to secure maximum annual records.

The next two sections are devoted to the correlation between the presence of broodiness and annual rate above the mean of broodies and non-broodies combined, using the high broody flock of 1916 and the low broody flock of 1923. Such a study shows the relative importance of broodiness in determining annual rate in a flock of low and high fecundity.

14. Correlation Between the Presence of Broodiness and Annual Rate above the Mean of Broodies and Non-broodies Combined—Pullet Year (Unimproved Flock 1916).

Annual Rate	Broody	Non-Broody
Number above population mean	165	31
Number below population mean	159	18
Totals	324	49

Coefficient of correlation —.2480 ± .0328

This constant agrees well with that for the whole eight-year period. It is significant and illustrates the negative relation between broodiness and high annual rate in an unimproved flock.

15. Correlation Between the Presence of Broodiness and Annual Rate above the Mean of Broodies and Non-broodies Combined—Pullet Year (Improved Flock 1923).

Annual Rate	Broody	Non-Broody
Number above population mean	60	164
Number below population mean	76	129
Totals	136	293

Coefficient of correlation —.2338 ± .0308

This coefficient does not differ significantly from the coefficient obtained on the 1916 flock in section 14 or from the constant on all flocks in section 13. Evidently the relation of broodiness to annual rate has not changed with the improvement in fecundity.

In the previous sections, the relation between *times broody* and rate or intensity of production has been considered. A considerable body of evidence has been presented to indicate first, that hens with the broody trait do tend to lay more intensely during the winter season than non-broody hens; second, that broodiness is a considerable handicap to annual production in that it lowers the annual rate. The next consideration is the relation of *total days broody* during the pullet year to December rate, winter rate and annual rate.

16. Correlation Between Total Days Broody and December Rate—Pullet Year.

In this study the same group of 1945 birds both broody and non-broody that were studied in relation of times broody to December rate (section 1) is considered. It is important to know which is the more important from the standpoint of rate, the number of broody periods or the actual number of days spent in broodiness calculated so as to avoid winter pause and fall molt. Constants calculated on this group of birds follow:—

Number of birds	1945
Mean total days broody	23.20
Total days broody standard deviation . . .	±27.07
Mean December rate	59.60
December rate standard deviation . . .	±20.40
Coefficient of correlation	+.0529 ± .0153

The standard deviation in total days broody exceeds the mean total days broody because of the large percentage of non-broody birds in the group studied.

The coefficient of correlation agrees rather closely with the figure given in section 1 where times broody and December rate are considered. Evidently broodiness may be measured either by periods or by total days. The degree of correlation is slight, and it is really a false correlation because based upon a mixed population—broody and non-broody.

17. Correlation Between Total Days Broody and December Rate for Broody Birds Alone—Pullet Year.

The relation between degree of broodiness, as measured by total days of non-production associated with broodiness during the pullet year, and December rate may be determined by using only the birds that went broody the first year. Such a determination was made for the same group of 949 birds that was considered in section 2. The following are the constants:—

Number of birds	949
Mean total days broody	42.84
Total days broody standard deviation . . .	±27.38
Mean December rate	61.24
December rate standard deviation . . .	±20.11
Coefficient of correlation	—.0002 ± .0219
Regression broodiness on rate	—.0003
Regression rate on broodiness	—.0001

That degree of broodiness and December rate are entirely independent is shown by the above coefficient of correlation which is practically zero. This is rather conclusive evidence that December intensity bears no relation to the presence or absence of the broody trait.

18. Correlation Between Total Days Broody and Winter Rate—Pullet Year.

A total of 2221 birds studied in section 6 are included in this study to discover the degree of dependence or independence between total days broody and winter rate. The constants calculated follow:—

Number of birds	2221
Mean total days broody	23.50
Total days broody standard deviation	±27.04
Mean winter rate	66.45
Winter rate standard deviation	±9 37
Coefficient of correlation	+.0178 ± .0142

The coefficient of correlation is practically the same figure as was obtained between times broody and winter rate. This is also a false correlation because broodies and non-broodies each represent a genetic type. Since winter production and annual production are so intimately correlated (Hervey 1923; Hays, Sanborn and James 1924), high winter record is of very great importance in breeding for fecundity.

Blakeman's test for linearity of regression has been applied in this study with the following results:

Correlation ratio for days broody	+.1134
Correlation ratio for winter rate	+.1695
(Cor. Ratio)^2 — (Cor. Coeff.)^2 =	.0075 ± .0024
(Cor. Ratio)^2 — (Cor. Coeff.)^2 =	.0233 ± .0043

The difference between the correlation ratio for winter rate squared and the correlation coefficient squared is .0233 ± .0043, a difference more than five times as great as its probable error. This fact indicates that the coefficient of correlation is false, as might be anticipated from the fact that two genetic races are concerned.

19. Correlation Between Total Days Broody and Winter Rate for Broody Birds Alone—Pullet Year.

Winter rate records are available on 1098 birds that were broody the first year. In this study days broody is tabulated against winter rate to further discover the correlation between degree of broodiness and winter rate. Constants are as follows:—

Number of birds	1098
Mean total days broody	42.85
Total days broody standard deviation	±27.14
Mean winter rate	67.57
Winter rate standard deviation	±9.63
Coefficient of correlation	—.0241 ± .0203
Regression broodiness on rate	—.0679
Regression rate on broodiness	—.0085

The coefficient of correlation as shown above signifies independence between degree of broodiness and winter rate. The intensity of the broody trait is therefore of no concern in affecting winter intensity.

20. Correlation Between Total Days Broody and Annual Rate—Pullet Year.

The total days broody for each bird are tabulated against her annual rate. The lowest rate class is 16-20; the highest rate class is 86-90. The lowest broody class is 0-9; the highest broody class is 150-159 days. This study on the 2245 birds used in section 11 will show if broodiness is an advantage or disadvantage from the standpoint of annual rate. Are broodiness and high intensity linked together? Constants calculated are:—

Number of birds	2245
Mean total days broody	23.68
Total days broody standard deviation	±26.98
Mean annual rate	56.48
Annual rate standard deviation	±9.85
Coefficient of correlation	—.2720 ± .0132

The coefficient of correlation between days broody and annual rate is negative and of such magnitude as to be of considerable significance, were it not for the fact that the two races of birds give a false correlation.

21. Correlation Between Total Days Broody and Annual Rate for Broody Birds Alone—Pullet Year.

The same group of birds considered in section 12 is used in this study. The coefficient of correlation is here used to measure the degree of association between degree of broodiness and annual intensity. Constants obtained are the following:—

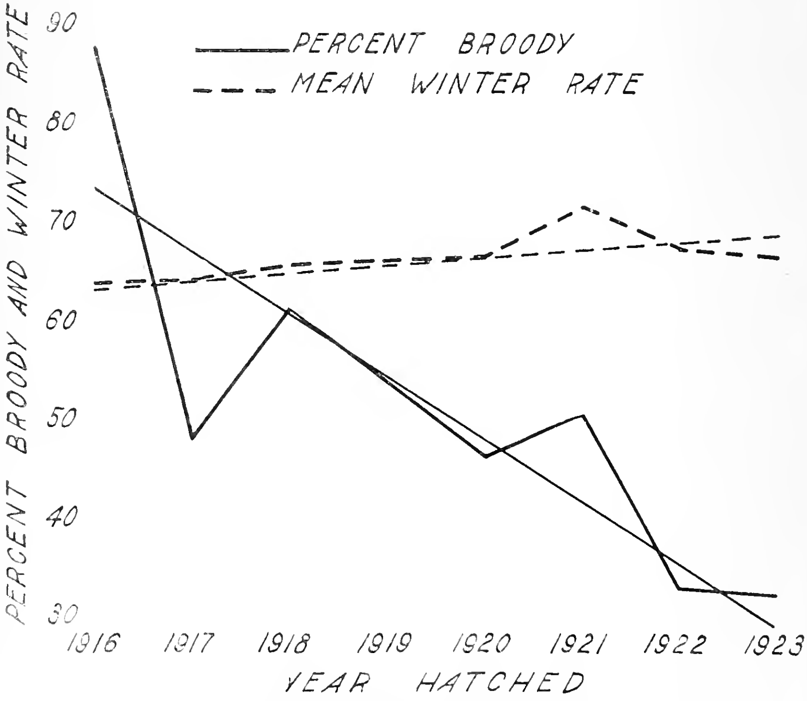

CHART 1. Relation of percentage of birds broody to mean winter rate by years.

Number of birds	1122
Mean total days broody	42.87
Total days broody standard deviation . . .	±26.84
Mean annual rate	54.93
Annual rate standard deviation	±9.24
Coefficient of correlation	—.3622 ± .0175
Regression broodiness on rate	—1.0526
Regression rate on broodiness	—.1216

A rather marked degree of negative correlation exists between days broody and annual rate. The degree of broodiness influences annual rate because of the loss of time while broody. This constant agrees substantially with the constant for times broody and annual rate (—.3232 ± .0180).

Relation of Broodiness to Winter Rate and Annual Rate.

In charts 1 and 2 the mean percentage of birds broody on the different years is illustrated graphically by a solid line. The mean winter rate and

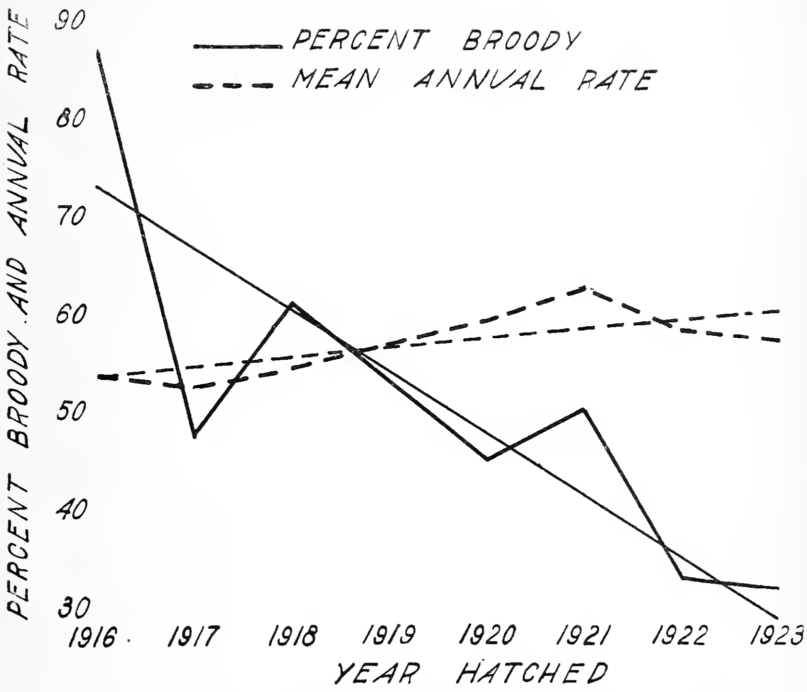

CHART 2 Relation of percentage of birds broody to mean annual rate by years.

mean annual rate are represented by broken lines. The groups of birds used in making the two charts are not identical because winter rate records are available on a considerable number of individuals that did not survive to complete annual records. However, the two groups are so nearly identical that the mean percentage of broody birds closely agrees in the two charts.

The increase in mean winter rate from 1916 to 1923 is 4.06, while the increase for annual rate in the same period is 6.00. This fact indicates that annual rate has increased more rapidly than winter rate as the percentage of broody birds has been reduced from year to year. The greater degree of parallelism in the two graphs on chart 1 suggests that a change in percentage of broody birds is usually accompanied by a change in winter rate. Chart 2 shows a lesser relationship between percentage broody and annual rate.

In general the two charts furnish evidence that both mean winter rate and mean annual rate may be increased while the percentage of broody birds is being reduced. The lowering of the percentage of broody birds to at least 30 per cent, as has been accomplished in the flock studied, appears to be advantageous from the standpoint of annual production.

The next section is devoted to a study of the relation between the number of broody periods and the mean length of broody periods. It seems desirable to ascertain if the average length of broody period is affected by the number of periods. Does the frequency of onset of broodiness tend to shorten or lengthen the period? The coefficient of correlation is again made use of and the number of broody periods is tabulated against the mean length of period, using 1135 birds that were broody in the pullet year.

22. Correlation Between Times Broody and Mean Length of Broody Periods—Pullet Year.

Any attempt to decrease the intensity of broodiness must be accomplished either by reducing the number of periods or by reducing the length of these periods. The coefficient of correlation is here calculated to discover a possible relationship between number and length of broody periods. Constants calculated are as follows:

Number of birds	1135
Mean times broody	2.89
Times broody standard deviation	±3.67
Mean length of periods	15.10
Length of periods standard deviation	±3.78
Coefficient of correlation	—.2338 ± .0189
Regression times broody on length	—.4620
Regression length on times broody	—.1183

The total number* of birds showing one or more broody periods is slightly greater than the number in sections 12, 21, 30 and 32, broody records being available on a few birds on which annual rate records are lacking. The stand-

*The total number of birds going broody was 1135. Of this group, 1017 individuals were first broody after March first so that the actual length of the period of nonproduction attributable to broodiness could be definitely recorded. There were 118 birds broody before March first. The mean length of broody period for the 1017 birds is 15.95 days, while that for the group of 1135 birds is 15.10 days. This slight difference in mean length of period is not significant and may be attributed to our inability to separate broody pause from winter pause in those 118 birds going broody before March first. The method of allowing a bird but four days to begin laying after her return to the laying house following broodiness during the winter season is faulty in that it actually assigns a shorter broody period during winter than the mean of summer broody periods.

ard deviation in times broody is greater than the mean because 951 birds (83 per cent) fell into classes 1-4, leaving only 17 per cent in classes 5-13. The modal class is 2.

The mean length of broody periods is 15.10 days with a standard deviation of ± 3.78. There is, therefore, much greater uniformity in length of period than is observed for number of periods. Evidently the number of periods offers a more fertile field for improvement than is offered by the length of period.

The negative coefficient of correlation indicates that an increase in number of broody periods is accompanied by a decrease in their average length. A reduction in number of periods would therefore be accompanied by an increase in their length. That this relationship is far from absolute is shown by the magnitude of the correlation coefficient. Certainly the time lost in non-production has been very significantly reduced by decreasing the number of broody periods, as table 1 shows.

23. Correlation Between Winter Rate and Annual Rate—Pullet Year.

The records for 2242 individuals both broody and non-broody are available for study. This relationship is important because both rates bear a rather intimate relation to egg production. The fact has previously been pointed out that broody birds tend to be more intense winter layers than are non-broody birds, but that the former are likely to carry a lower annual rate. An intimate correlation between winter rate and annual rate would suggest that rate of laying for the year may be predicted from the winter rate. Constants calculated are as follows:—

Number of birds	2242
Mean winter rate	66.41
Winter rate standard deviation	±9.38
Mean annual rate	56.46
Annual rate standard deviation	±9.85
Coefficient of correlation	+.4900 ± .0108

The above constants indicate a slightly greater relative standard deviation in annual rate than exists for winter rate. Such a condition might be surmised from the fact that broodiness and complete molt may both affect annual rate but for the most part are not concerned in winter rate.

A rather intimate correlation exists between winter and annual rate. Evidently those birds above the average in winter rate would be expected to be above the average in annual rate. The practice of selecting for high winter rate is without doubt sound from the standpoint of securing high annual rate.

24. Correlation Between the Presence of Broodiness and Winter Production above the Mean of Broodies and Non-broodies Combined—Pullet Year (Flocks 1916-1923).

The absolute correlation between the presence of broodiness and winter production above the mean of all birds is of much concern to poultrymen striving for high winter records. Such information will show whether or not broody birds tend to lay more eggs before March first than do broody-free birds. In section 8 some evidence is presented to indicate that broody birds do actually lay at a slightly higher rate than non-broodies when they are laying; but late sexual maturity, winter pause and the occasional winter broody period may possibly be more pronounced in the broody population. The actual correlation between the presence of broodiness and winter production above the mean is shown by the following table:—

Winter Production	Broody	Non-Broody
Number above population mean	561	561
Number below population mean	534	563
Totals	1095	1124

Coefficient of correlation $+.0264 \pm .0143$

The above coefficient is so small as to be of no significance and it is less than three times the magnitude of its probable error. The deduction must be made from this study that broodiness and winter egg production are entirely independent even though broody birds do lay at a slightly higher rate in winter when they are laying.

25. Correlation Between the Presence of Broodiness and Winter Production above the Mean of Broodies and Non-broodies combined—Pullet Year (Unimproved Flock 1916).

Winter Production	Broody	Non-Broody
Number above population mean	149	14
Number below population mean	140	29
Totals	289	43

Coefficient of correlation $+.3759 \pm .0318$

The above constant shows that broodiness bears a rather intimate correlation to high winter production in the 1916 flock. Such an assumption is based on the conclusion that the individuals laying more eggs in winter than the average of the flock (46.87 eggs) are high producers. Even though a small percentage of the 1916 flock reduced this winter record by being broody before March first, broody birds appeared to carry intensity to a sufficient extent to enable them to lay more eggs for the period than did the non-broody birds. It is rather striking that the total population (section 24) should not exhibit a constant similar to that for the 1916 flock. No doubt changes in early maturity and winter pause have operated to modify winter production to a greater extent than any possible lowering of intensity by the elimination of broodiness has been responsible for.

26. Correlation Between the Presence of Broodiness and Winter Production above the Mean of Broodies and Non-broodies Combined—Pullet Year (Improved Flock 1923).

Winter Production	Broody	Non-Broody
Number above population mean	77	140
Number below population mean	61	152
Totals	138	292

Coefficient of correlation $+.1563 \pm .0317$

This constant is of questionable magnitude and signifies that winter production of the 1923 flock above the mean of 53.62 eggs is but little dependent upon the presence of the broody trait. The fact should be recalled, however, that the maximum winter production (74.5 eggs) was made by the 1921 flock with 44.56 per cent of the birds broody during the pullet year.

The later sections of this report are devoted to a consideration of the correlation between rate and egg yield and broodiness and egg yield.

27. Correlation Between Winter Rate and Annual Egg Production—Pullet Year.

In commercial poultry breeding for fecundity, a short-time measure of probable annual production is of vast importance. If the winter rate could be used as a basis for selecting breeding females as efficiently as the yearly record, it would be of vast economic importance. By making use of the coefficient of correlation, a measure of the probable worth of the winter rate in selecting for large yearly records is obtained. The constants arrived at in this study are given below:—

Number of birds	2242
Mean winter rate	66.41
Winter rate standard deviation	± 9.38
Mean annual production	174.37
Annual production standard deviation	± 44.59
Coefficient of correlation	$+.4561 \pm .0113$

The mean annual egg production of the 2242 birds used in section 27 was 174.37, with a standard deviation of 44.59, or a coefficient of variation of about 25 per cent. The class range in egg production is from 21 to 300 with class intervals of 10. This wide range in production is due to the heterogeneity of the flock and to the number of characteristics that affect production.

The magnitude of the correlation coefficient, together with the small probable error, suggests that winter rate is rather intimately correlated with annual egg production.

28. Correlation Between Annual Rate and Annual Egg Yield.

Annual rate as calculated for this flock is a rather concise measure of intensity for the entire pullet laying year. It should furnish a reasonably true measure of the bird's ability to lay throughout the year. Since the relation of broodiness to annual rate has already been considered, it seems advisable to correlate annual rate with annual yield. The calculations gave the following constants:

Number of birds	2289
Mean annual rate	56.38
Annual rate standard deviation	±9.86
Mean annual egg yield	172.21
Annual egg yield standard deviation . . .	±46.61
Coefficient of correlation	+.6717 ± .0077

A very sensible positive correlation was found between annual rate and annual egg yield. Annual rate is thus a very dependable measure of a bird's ability to lay during her pullet year.

29. Correlation Between Times Broody and Annual Production—Pullet Year.

The records of 2245 birds broody and non-broody are tabulated and the coefficient of correlation calculated between times broody and annual production. Constants arrived at follow:—

Number of birds	2245
Mean times broody	1.44
Times broody standard deviation	±1.98
Mean annual production	173.06
Annual production standard deviation . .	±46.40
Coefficient of correlation	—.2126 ± .0136

This constant is false because the table is made up of two genetically distinct races, namely, broody and non-broody.

TABLE 2.—Relation of Broodiness to Egg Record.

Times Broody	Number of Birds	Egg Record
0	1121	181.31
1	312	178.32
2	259	156.62
3	220	156.50
4	149	158.65
5	72	162.58
6	47	153.59
7	28	140.14
8	17	155.50
9	9	147.72
10	5	145.50
11	2	160.50
12	1	155.50
13	1	145.50

Reference to table 2 above shows that the 1121 non-broody birds averaged 181.31 eggs per year. Close to this group in production is the class of 312 birds with but one broody period, averaging 178.32 eggs. A somewhat gradual but not regular decline begins with the group broody twice. No further decline is observed until the group with six broody periods is reached, after which the mean egg yield falls significantly. The probable error increases so rapidly due to small numbers when the class with eight broody periods is reached that very little significance can be attached to the mean in this and later classes. On the whole, this table suggests in a general way that increased broodiness does lower the annual record.

30. Correlation Between Times Broody and Annual Egg Yield for Broody Birds Alone—Pullet Year.

A true measure of the correlation between times broody and annual production can only be found within the broody population as previously stated. In the eight-year period 1122 broody birds are concerned. This group has been tabulated and constants calculated.

Number of birds	1122
Mean times broody	2.89
Times broody standard deviation	$\pm$1.91
Mean annual production	164.89
Annual production standard deviation . . .	$\pm$45.03
Coefficient of correlation	—.1791 $\pm$ .0195
Regression broodiness on production . . .	—.0076
Regression production on broodiness . . .	—4.2167

A negative coefficient of correlation of .1791 $\pm$ .0195 indicates that the correlation between times broody and annual production may not be considered intimate. Such a constant leads to the assumption that broodiness as measured by periods has played some part in limiting annual production for the eight-year period studied.

31. Correlation Between Total Days Broody and Annual Production—Pullet Year.

Broodiness may next be measured in total days for the year. This method of measuring has been made use of between total days broody, and annual egg production. The birds used in this tabulation are 2245 in number, both broody and non-broody. Constants calculated follow:—

Number of birds	2245
Mean total days broody	23.68
Total days broody standard deviation . . .	$\pm$26.98
Mean annual production	173.06
Annual production standard deviation . .	$\pm$46.40
Coefficient of correlation	—.2200 $\pm$ .0135

An interesting and important fact is brought out by the above constants in that the correlation between total days broody and annual egg record is negative and of almost the same magnitude as that obtained between times broody and annual egg record (section 29). The deduction that broodiness lowers annual record again seems warranted, but the coefficient obtained in this table is false because of the presence of the genetically different broodies and non-broodies.

32. Correlation Between Total Days Broody and Annual Egg Yield for Broody Birds Alone—Pullet Year.

A tabulation made of the 1122 broody birds gives the true correlation between degree of broodiness and pullet-year production. Constants obtained are the following:—

Number of birds	1122
Mean days broody	42.87
Days broody standard deviation	±26.84
Mean annual production	164.89
Annual production standard deviation	±45.03
Coefficient of correlation	—.1964 ± .0194
Regression days broody on production	—.1171
Regression production on days broody	—.3295

The degree of correlation between total days broody and annual egg record is not at all intimate. It is in very close agreement with the constant for times broody and annual egg yield, in section 30. On the whole, broodiness has been shown to be negatively correlated with annual production to a rather moderate degree over the eight-year period covered in this report.

33. Correlation Between the Presence of Broodiness and Annual Production above the Mean of Broodies and Non-broodies Combined—Pullet Year (Flocks 1916-1923).

The true correlation between the presence of broodiness and high annual egg production is determined below.

Annual Production	Broody	Non-Broody
Number above population mean	514	665
Number below population mean	608	458
Totals	1122	1123

Coefficient of correlation —.2640 ± .0132

The above constant is statistically significant and is of sufficient magnitude to warrant the assumption that broodiness is negatively correlated with high annual production. The fact that annual egg record depends upon a vast array of genetic and non-genetic factors should not be overlooked. During the eight-year period being considered there has been constant progress in eliminating broodiness, yet the mean annual egg records of the flocks have been stable since 1920. Very likely broodiness has played a greater part in affecting production in some years than on others. The two following sections show that the correlation between broodiness and annual record has not been intimate either in 1916 or 1923.

34. Correlation Between the Presence of Broodiness and Annual Production above the Mean of Broodies and Non-broodies Combined—Pullet Year (Unimproved Flock 1916).

Annual Production	Broody	Non-Broody
Number above population mean	165	27
Number below population mean	159	22
Totals	324	49

Coefficient of correlation — .0837 ± .0347

The correlation coefficient is negative and less than three times its probable error. The conclusion seems to be warranted that in the 1916 flock there is no significant correlation between broodiness and annual production.

35. Correlation Between the Presence of Broodiness and Annual Production above the Mean of Broodies and Non-broodies Combined—Pullet Year (Improved Flock 1923).

Annual Production	Broody	Non-Broody
Number above population mean	67	164
Number below population mean	69	129
Totals	136	293

Coefficient of correlation — .1339 ± .0320

This coefficient is about four times its probable error and is probably of some significance. The degree of correlation between broodiness and annual production is slight on the two years studied; a fact that probably indicates more correlation on the intervening years.

General Summary and Deductions

The means for the broodies and non-broodies for the three rates and for winter and annual production for the eight-year period are as follows:—

	Broody		Non-broody	
	Number of Birds	Mean	Number of Birds	Mean
December Rate	949	61.24	996	58.05
Winter Rate	1098	67.57	1123	65.36
Annual Rate	1122	54.93	1122	58.04
Winter Production	1094	60.46	1123	58.79
Annual Production	1122	161.89	1121	181.31

1. Birds carrying the broody trait lay at a slightly higher rate when they are laying than do non-broody birds. This characteristic is observable in both December records and in winter records.

2. A much more intimate correlation between the presence of broodiness and high December intensity was observed in the 1916 flock than in the 1923 flock. This difference may probably be attributed to changes in sexual maturity and to the time of onset and termination of winter pause.

3. Intensity for the winter period is rather intimately correlated with the presence of broodiness. Such a relationship is observed in the total population for the eight years, in the 1916 flock and in the 1923 flock.

4. Degree of broodiness is not correlated with either December rate or winter rate.

5. The degree of correlation between broodiness and high annual rate is constant but negative and significant.

6. Degree of broodiness may be measured with equal accuracy by number of broody periods or by total days broody during the pullet year.

7. Winter rate and annual rate are distinctly positively correlated.

8. The duration of the broody period is somewhat lessened as the number of periods increases.

9. Correlation between the presence of broodiness and winter production above the average is negligible when all the birds are considered over the eight-year period. There is a significant positive correlation for the 1916 flock and probably a slight correlation within the 1923 flock.

10. The mean winter egg record of broodies is not significantly greater than that of non-broodies.

11. Annual egg production is significantly negatively correlated with broodiness in the total population studied; to a very minor degree in the 1916 flock; and to a rather moderate degree in the 1923 flock.

12. The elimination of broodiness has had but little significance in breeding for high winter production but a pronounced significance in breeding for high annual records.

References

Bateson, W. 1902. Experiments with poultry. Rpts. to Evolution Com., Roy. Soc. [London] **1**:87-124

Blakeman, J. 1905. On tests for linearity of regression in frequency distribution. Biometrika **41**:332-350.

Davenport, E. 1907. Principles of breeding. p. 471. Boston, New York. etc.: Ginn & Co.

Goodale, H. D., Ruby Sanborn and Donald White. 1920. Broodiness in domestic fowl. Mass. Agr. Expt. Sta. Bull. 199.

Goodale, H. D. and Ruby Sanborn. 1922. Changes in egg production in the station flock. Mass. Agr. Expt. Sta. Bull. 211.

Harris, J. A. 1915. Physical conformation of cows and milk yield. Jour. Hered. **6**:348-350

Harris, J. A. and H. D. Goodale. 1922. The correlation between the egg production of the various periods of the year in the Rhode Island Red breed of domestic fowl. Genetics **7**:446-465.

Hays, F. A. 1924. Inbreeding the Rhode Island Red fowl with special reference to winter egg production. Amer. Nat. **58**:43-59.

Hays, F. A., Ruby Sanborn and L. L. James. 1924. Correlation studies on winter fecundity. Mass. Agr. Expt. Sta. Bull. 220.

Hervey, G. W. 1923. The prediction of egg records. N. J. Agr. Expt. Sta. Bull. 389.

Hurst, C. C. 1905. Experiments with poultry. Rpts. to Evolution Com., Roy. Soc. [London] **2**:131-154.

King, W. I. 1923. The elements of statistical method. p. 215. New York: Macmillan Co.

Pearl, R. 1914. Studies on the physiology of reproduction in the domestic fowl. VII. Data regarding the brooding instinct in relation to egg production. Jour. Anim. Behavior **4**:266-288.

Punnett, R. C. and P. G. Bailey. 1920. Genetic studies in poultry. II. Inheritance of egg color and broodiness. Jour. Genet. **10**:277-292.

MASSACHUSETTS
AGRICULTURAL EXPERIMENT STATION

TECHNICAL BULLETIN No. 8 JULY, 1926

WINTER CYCLE AND WINTER PAUSE IN RELATION TO WINTER AND ANNUAL EGG PRODUCTION

By F. A. HAYS and RUBY SANBORN

In this bulletin are reported the results of a statistical study of winter cycle and winter pause records taken over a period of nine years, with as many separate flocks. The records show that winter cycle furnishes a significant short-time measure of probable annual egg production in the flock. Winter pause is shown to be a potent cause of lowered annual egg production; and any increase in length of pause is but partially compensated for by later increased activity in egg production.

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AGRICULTURAL EXPERIMENT STATION

AMHERST, MASS.

WINTER CYCLE AND WINTER PAUSE IN RELATION TO WINTER AND ANNUAL EGG PRODUCTION.

By F. A. HAYS and RUBY SANBORN

Introduction

Winter cycle is represented by a period of continuous egg laying during the winter season. February 28 or 29th is arbitrarily chosen as the closing date of the winter period. A distinct cessation of laying before the end of February may be assumed to mark the end of the winter laying cycle. Just what length of pause should be chosen to mark the end of the winter laying cycle is purely arbitrary. Goodale (1918) suggested that a ten-day cessation of laying is sufficiently small to mark the end of the winter cycle. In the studies reported here, a four-day interval is considered as a winter pause because, in the flock studied, such a pause generally means the omission of one clutch* of eggs. The omission of one clutch of eggs really marks a distinct break in the functioning of the reproductive system and probably represents the termination of a laying cycle. Pauses due to broodiness or to injury or disease are not considered, and only pauses occurring between November 1 and February 28 or 29 are classed as winter pauses or as marking the end of the winter cycle.

Winter cycle may further be defined as total days from date of first egg to a pause of four or more days, the pause being considered only between the dates November first and March first. Winter cycle length can therefore be determined only for the pause class of birds, as Goodale (1918) pointed out. Winter cycle is probably inherited as a recessive, according to Goodale (loc. cit.); but he failed to discover a relationship between number of eggs laid in the winter cycle and duration of winter pause.

Winter pause may be defined as the period when egg production ceases, following the termination of the winter cycle and previous to the initiation of the spring laying cycle. Pearl (1912) and Goodale (1918) make reference to winter pause in relation to fecundity. Pearl (loc. cit.) found that the winter cycle in Barred Plymouth Rocks was characteristically terminated by a cessation of production. Goodale (loc. cit.), on the other hand, observed a cessation of production previous to March first in but a part of a Rhode Island Red flock. Goodale (1922) states that winter pause is due in part to inherited characteristics and in part to environmental conditions. He discovered a rather intimate relation between the time of beginning to lay in the fall and the appearance and duration of the winter pause.

Winter pause is usually associated with the shedding of some feathers, or partial molt, as Hays (1924) suggested. Furthermore, a cessation of production during broodiness or at any other time during the laying year is

* The term "clutch" refers to the number of eggs laid on successive days, which is more or less characteristic of the individual hen.

generally characterized by partial or complete molt. Apparently molting, which precedes the development of a new growth of feathers, is a phenomenon initiated by a cessation of active functioning of the reproductive system. A number of environmental influences as well as inherent fecundity thus appear to be concerned in the different pauses of the pullet laying year. The sum total of the winter pause may or may not be represented by a continuous period of non-production. In other words, there may be several pauses of four or more days with some production intervening. In these studies such pauses have been added together and such individuals placed in the same class with birds whose pause is unbroken.

The duration* of winter pause is recognized to be dependent upon environmental conditions such as hatching date, feeding and housing, weather conditions, and all other influences that may affect the physical condition and state of metabolism of the pullet. Since age at which sexual maturity is attained is modified by such controllable conditions as date of hatching, as Hays and Sanborn (1924) point out, and since age when sexually mature largely governs the time of beginning to lay, a complex relationship must exist between age at first egg and winter pause.

The presence or absence of winter pause depends upon inheritance, as Hays (1924) points out. Pullets that exhibit a winter pause of a week or more before March first are known to carry a dominant factor M, while non-pause pullets are recessive and lack factor M. This factor is transmitted equally by both males and females. In this connection, breeders should bear in mind that genetically non-pause pullets may exhibit a winter pause brought on by disease, abrupt changes of feed, moving to new quarters, and other environmental influences largely within control of the poultryman. In the breeding flock of the Massachusetts Agricultural Experiment Station extreme care has been exercised to keep environmental conditions constant from year to year in order that inherited traits affecting fecundity may be studied.

Character of Birds Used

This study includes all Rhode Island Red females, hatched from 1916 to 1924, on which pullet-year trapnest records are available. The flocks each year are made up of all the daughters from each individual female whose progeny was retained. Culling within the family has not been practiced. The major portion of birds in each flock belong to the fecundity experiment. There are, however, a limited number of birds bred for non-broodiness, some for intense broodiness, some for hatchability, some for color, and a few inbreds that are included. Pullet-year records alone are used in this study. The heterogeneity of the flock can scarcely be considered as a factor affecting the constants presented in this report.

Two possible methods are open for attacking these questions in a large population made up from nine years' breeding for fecundity. The first method is the use of the coefficient of correlation. The second possible mode of attack is through the presentation of actual data by families tracing to both foundation males and females through nine successive years. The possibilities of the two methods may be briefly considered.

* In a small percentage of the flock the pause began late in February and such birds did not resume laying until some time in March or later. In these cases, duration of pause is calculated when production is actually resumed.

The Coefficient of Correlation.

A general survey of a series of individual egg records may lead to certain general deductions some of which may actually be true and others false. The breeder needs to know just how much stress to lay upon different characteristics associated with the traits concerned in high fecundity. The simple correlation coefficient affords a concise measure of the degree of association between specific traits and high fecundity as well as a measure of the relationship between the presence of particular traits and high fecundity. The correlation coefficient may thus be made use of by the breeder in two ways: first, for prediction purposes; and second, in the selection of breeding stock to obtain the most valuable combination of traits. Stated concisely, the correlation coefficient is the only direct and specific measure for degree of association of characteristics where large numbers of individuals are concerned. Fecundity records may be modified by a vast number of environmental conditions as well as by the five traits pointed out by Goodale and Sanborn (1922) which are shown to be inherited. Hays (1924). Only by the use of large numbers of records made over a period of years under uniform conditions of management and in a flock bred for uniformity can a true value of the relative importance of characteristics concerned with fecundity be approached. The coefficient of correlation thus becomes an invaluable tool in breeding for fecundity.

Presentation of Data by Families.

A study undertaken to consider the winter cycle and winter pause by separate families would necessitate the presentation of page after page of abstract data. Such data should be accompanied by detailed and complete discussions and such general deductions as would seem justified. No definite constants could be determined on numbers so small as the individual family. Possibly all the descendants of particular individuals could be considered as units, but from the genetic standpoint such a consideration should be classed as questionable. A general tabulation of the whole population, giving such information as mean hatching date, mean age at first egg, mean weight at first egg, percentage of birds pausing, mean length of pause, mean winter production, mean annual production, etc., by years could be made. Such a tabulation would again be open to the criticism of not furnishing specific information. Only general deductions could be made and no evidence would be furnished as to relative values. In view of the above facts, this method of handling the data is not considered feasible.

Winter Cycle

Winter cycle may be considered in three general categories: namely, (a) in its relation to environmental conditions, (b) in its relation to heritable characteristics concerned in fecundity, and (c) in its absolute relation to egg production.

(a) Relation of Environmental Conditions to Winter Cycle.

Hatching date belongs to the definitely controllable class of conditions in that it may be varied at will of the investigator. Date of first egg depends both upon environment and inheritance. The time when a group of pullets will begin to lay depends in part upon hatching date, method of feeding and management, and upon weather conditions—all of which may be classed as environmental. The dependence of date of first egg upon age when beginning to lay, however, is a relation to a heritable trait, since Hays (1924) has shown age at first egg to be inherited.

1. Correlation Between Hatching Date and Length of Winter Cycle.

Time of hatching is generally believed to hold an important relation to the time of appearance of winter pause. Since the appearance of winter pause marks the termination of the winter cycle, the possibility exists of a relationship between hatching date and length of winter cycle. The table presented below tends to substantiate a relation between date of hatching and length of winter cycle for the *total* population of birds actually manifesting a winter cycle terminated by a pause:

Hatches	Number of Birds	Mean Length of Winter Cycle
1	329	68.33 Days
2	267	62.54 "
3	286	59.56 "
4	281	51.91 "
5	258	47.05 "
6	237	42.00 "
7	225	36.21 "
8	195	38.78 "
Grand Average		52.26 "

The mean length of winter cycle is shown to consistently decrease as the hatching date advances, with but a single exception in the last hatch. There are eight hatches each year at one week intervals from March 25 to May 15. The total difference in age between the first and last hatches is 49 days, while the difference in mean winter cycle length is 30 days. The ability of the later hatched pullets to reach sexual maturity at a slightly earlier age than do early hatched pullets (Hays, Sanborn, and James, 1924) probably accounts for the minor inconsistencies in the above table. The means of the eight different hatches for the nine-year period covered by the table indicate a rather important relationship between date of hatching and length of winter laying cycle, which is determined by the onset of winter pause. In this connection, the reader should bear in mind that only winter pause birds are included in the tabulation because no winter cycle can be ascertained in non-pause birds.

The absolute relation between hatching date and length of winter cycle may be discovered by means of the coefficient of correlation. Available for study are 2078 birds. Class intervals of ten days are used for winter cycle in calculating the following constants:

Number of birds	2078
Mean hatching date (Apr. 17)	4.18
Hatching date standard deviation	± 2.26
Mean length of winter cycle	52.26
Winter cycle standard deviation	± 34.23
Coefficient of correlation	$-.3174 \pm .0133$
Regression of hatching date on winter cycle length .	$-.021$
Regression of winter cycle length on hatching date .	-4.811

A significant negative coefficient of correlation informs that, in general, early-hatched pullets have a longer winter laying cycle than late-hatched pullets of the same flock. The magnitude of the constant does not establish an intimate relationship, however, and for this reason the influence of other forces is evident. An increase in length of laying cycle is important from the breeding standpoint, because it signifies a greater mean winter record, and winter production is intimately correlated with annual production (Hays, Sanborn and James, 1924).

2. Correlation Between Date of First Egg and Length of Winter Cycle.

Date of first egg is very important economically. Its significance biologically depends upon the influence of weather conditions on egg production. Specific data concerning the influence of weather on fecundity are not available, however. There is a considerable body of evidence pointing toward a seasonal periodicity of production which has led a number of workers to consider winter, spring, summer and autumn cycles of laying.

In this experiment 2078 pullets with definite winter cycles are available for study. Fifteen-day class intervals are used in grouping data of first egg, and the range in dates is August 24 to February 20. Below are the constants calculated:

Number of birds	2078
Mean date of first egg (Oct. 29)	5.93
Date of first egg standard deviation	±2.09
Mean length of winter cycle	52.26
Winter cycle standard deviation	±34.23
Coefficient of correlation	—.5307 ± .0106
Regression of date of first egg on winter cycle	—.032
Regression of winter cycle on date of first egg	—8.689

The date of first egg fluctuates widely in the population studied. The mean date of first egg for the 2078 birds studied is October 29. In breeding for fecundity this variability in time of beginning to lay may be reduced genetically and also by providing a more uniform environment.

A negative coefficient of correlation of substantial magnitude demonstrates that early laying makes for a long winter cycle. The relation that winter cycle length holds to egg production remains to be considered in sections 4 and 5 of this report.

(b) Relation of Heritable Traits to Winter Cycle.

Age at first egg is a definitely heritable trait (Hays, 1924). It has been shown by a number of workers to be intimately correlated with both winter and annual fecundity. This study shows how age at first egg is related to length of the winter laying cycle. Sexual maturity is the only heritable characteristic reported on in relation to winter cycle.

3. Correlation Between Age at First Egg and Length of Winter Cycle.

The same group of 2078 pullets has been studied to ascertain the correlation between age at first egg and length of the winter laying cycle. Class intervals of ten days have been used for age, and the respective ages of the individuals tabulated against their winter cycle length. The constants determined are as follows:

Number of birds	2078
Mean age at first egg	203.66
Age at first egg standard deviation	±25.92
Mean length of winter cycle	52.26
Winter cycle standard deviation	±34.23
Coefficient of correlation	—.4529 ± .0118
Regression of age on winter cycle	—.343
Regression of winter cycle on age	—.598

Age at first egg varies within moderate limits. Since genetically-early and genetically-late birds are concerned, and because environment probably modifies age and sexual maturity, the standard deviation of age is not excessive.

A significant negative correlation is shown, as might be anticipated from the constants obtained in section 2. Age of sexual maturity may be classified as a characteristic influencing the length of winter cycle as determined by the onset of winter pause. Here is an example of a heritable trait being negatively correlated with duration of winter cycle.

(c) Relation of Winter Cycle to Egg Production.

A knowledge of the relation of winter cycle length to winter fecundity and annual fecundity is of value for prediction purposes. If any short-time measure of fecundity that is reasonably accurate in predicting winter and annual production is discovered, it will be of much economic import. Proper culling enables the poultryman to raise mean flock production by disposing of mediocre layers. If a relatively short season of trapnesting gives a clue to probable production for the year, such information will greatly assist poultrymen. This section considers the correlation between length of winter cycle and winter production and length of winter cycle and annual production. Since the winter cycle length for each bird is tabulated against her egg record, a true measure of degree of correlation is arrived at.

4. Correlation Between Length of Winter Cycle and Winter Egg Record.

Both length of winter cycle and winter egg record are placed in class intervals of ten for the 2078 individual pullets studied. The following constants were determined:

Number of birds	2078
Mean length of winter cycle	52.26
Winter cycle standard deviation	±34.23
Mean winter production	56.99
Winter production standard deviation	±23.40
Coefficient of correlation	+.6538 ±.0085
Regression of winter cycle on production	+.956
Regression of production on winter cycle	+.447

Mean length of winter cycle is 52.26 days while mean winter production is 56.99 eggs. Winter production exceeds the production of the winter laying cycle because most of the pullets resume laying previous to March first following a pause. An arbitrary termination of the winter season at the close of February in all cases does not give a true measure of winter production and no definite calendar date will suffice.

The standard deviations of both winter cycle and winter production are excessive. This fact further establishes the variability as due to inheritance and environment.

The above constant discloses a very intimate positive correlation between length of winter cycle and winter production. Here is concrete evidence establishing an important relation between long winter cycle and high winter egg record.

The importance of optimum hatching date, age at first egg, and date of first egg in relation to the length of the winter laying cycle has been presented in sections 1, 2, and 3. Possibilities of shortening the pause period by breeding methods are to be handled in another publication. Probably the most important consideration is the correlation between length of winter cycle and annual egg production, studied in the next section.

5. Correlation Between Length of Winter Cycle and Annual Production.

Annual egg record depends upon a vast array of environmental forces and upon a series of Mendelian factors. Specific information concerning many of these influences has never been presented. This section attempts to present in concrete form the relation of length of winter cycle to annual production over a period of years. On 1314 pullets the following constants appear:

Number of birds	1314
Mean length of winter cycle	53.52
Winter cycle standard deviation	$\pm$34.87
Mean annual production	172.53
Annual production standard deviation	$\pm$41.13
Coefficient of correlation	$\pm$.4027 $\pm$ .0156
Regression of winter cycle on production . . .	+.341
Regression of production on winter cycle . . .	+.475

This group of birds averaged slightly under 173 eggs during their pullet laying year of 365 days beginning with their first egg. The standard deviation in production illustrates a wide range of fluctuation. The actual range in annual egg production was from 35 to 275.

A positive correlation of substantial magnitude exists between winter cycle length and annual egg record. Length of winter cycle, therefore, furnishes a rather dependable short time measure of probable annual production for a population. Winter cycle length is discernable only for pullets exhibiting winter pause. By trapnesting during the first part of the laying year, it is possible to discover the length of the winter cycle and consequently the time of appearance of its complement, the winter pause.

Winter Pause

In the following table are given the number of pause and non-pause birds by years, together with the percentage of birds in the pause class.

Year	Number of Non-Pause Birds	Number of Pause Birds	Total	% With Pause
1916	120	159	279	56.99
1917	153	239	392	60.97
1918	115	248	363	68.32
1919	59	109	168	64.88
1920	48	133	181	73.48
1921	276	175	451	38.80
1922	201	376	577	65.16
1923	109	353	462	76.41
1924	160	340	500	68.00

The average length of pause for those birds pausing is as follows:

1916 flock	29.46 days
1921 flock	19.23 days
1924 flock	32.97 days

6. *Correlation Between Length of Winter Cycle and Length of Winter Pause.*

The range in cycle length was found to be from 5 days to 175 days. The class interval used was 10 days. Since winter cycle and winter pause are complementary to each other, it is important to discover their possible relation to each other. The coefficient of correlation will illustrate any tendency for length of winter cycle and length of winter pause to move in the same or in opposite directions. Such information will make clearer their physiological relationships and possible genetic linkage.

Number of birds	2078
Mean length of winter cycle	52.26
Length of winter cycle standard deviation . . .	±34.23
Mean length of winter pause	31.91
Length of winter pause standard deviation . .	±21.68
Coefficient of correlation	—.1385 ± .0145
Regression winter cycle on pause	—.219
Regression pause on winter cycle	—.088

The length of winter cycle as measured in these studies is subject to wide fluctuation as indicated by the relative magnitude of the mean and its standard deviation. Such fluctuations are to be anticipated in a population highly variable for the seven pairs of inherited factors concerned in winter production, subjected to uncontrollable variation in environmental influences. The fact should be observed, however, that the mean length of winter cycle is about 63 per cent greater than the mean length of pause.

A small negative correlation coefficient indicates a very slight tendency for long-cycle birds to pause for a shorter period than do short-cycle birds. This constant is subject to error, however, in that any increase in length of winter cycle reduces the possible pause interval before March first. The coefficient of correlation as calculated is of value in that it gives the actual relationship between length of winter cycle and duration of pauses within the winter season. These data furnish very good evidence that the length of winter pause does not depend upon the length of the winter cycle of laying.

In this report consideration is given to the winter pause from three general standpoints, namely, (a) Environmental factors affecting duration of the pause; (b) Inherited characteristics concerned with fecundity in relation to winter pause, and (c) The absolute relationship of winter pause to egg production.

(a) Environmental Factors Affecting Duration of Pause.

Much concern should be given to the relation of environmental factors affecting the duration of the winter pause since these conditions are more or less under the control of the poultryman. In the group of environmental factors the following have been placed: hatching date and time of beginning to lay in the fall. The time of year when pullets begin to lay is clearly dependent both upon management and inheritance. Management is a factor when the hatching date remains constant because housing, range, and feeding may either retard or accelerate sexual maturity. Just how significant these environmental influences are on time of beginning to lay in comparison with inherited early or late sexual maturity remains to be determined. At any rate, hatching date can be definitely controlled and time of beginning to lay may be considered as partially controllable.

7. Correlation Between Hatching Date and Length of Winter Pause.

A very common observation among poultrymen is that early-hatched pullets are more likely to exhibit winter pause than are late-hatched birds of the same flock. In other words, the belief is prevalent that the earlier the hatching date, the longer the winter pause. Such observations have naturally led to the assumption that the pullet possesses capacity to lay a certain number of eggs in the fall and winter and if this number is laid early there will be a cessation of laying until the spring season. That hatching date is only one of several conditions operating to affect the onset and duration of winter pause has been shown by Hays (1924) and Hays, Sanborn, and James (1924). Age at sexual maturity has been pointed out as an inherited characteristic, and as a characteristic having greater effect than hatching date upon winter egg production. Furthermore, winter pause of seven or more days' duration is an inherited characteristic. The importance of knowing just how intimate a relationship exists between date of hatching and duration of winter pause becomes apparent and may be discovered by means of the coefficient of correlation.

A total of 2134 birds exhibited a pause of four or more days and are included in these calculations. The winter pause class interval is ten days in all cases. Constants obtained from this study follow:

Number of birds	2134
Mean hatching date (Apr. 17)	4.15
Hatching date standard deviation	±2.26
Mean length of winter pause	32.26
Winter pause standard deviation	±21.92
Coefficient of correlation	—.2480 ± .0137
Regression of hatching date on winter pause	—.026
Regression of winter pause on hatching date	—2.404

The mean length of the winter pause over the entire nine-year period amounts to 32.26 days for the pause birds, but a striking fluctuation in the duration of the pause is revealed by its standard deviation. Environmental influences may be considered as largely responsible for the fluctuations. Any possible changed environment to shorten the pause would be advantageous economically.

The coefficient of correlation measuring the degree of association between time of hatching and duration of winter pause is negative, of moderate magnitude, and certainly significant. Clearly, a reduction in the range of hatching dates would tend to reduce the length of the period of non-production during the winter season. The mean length of winter pause of the eight different hatches studied follows:

Hatches	No. of Birds	Mean days Paused
1	353	39.41
2	271	37.35
3	293	36.46
4	289	33.84
5	261	28.22
6	245	25.99
7	227	25.85
8	195	24.32
Grand Average		32.26

8. Correlation Between Hatching Date Earlier Than The Mean and the Presence of Winter Pause For Entire Population.

Yule's short method as cited by Davenport (1907) is used in this study. This tabulation includes the total population, 3375 Rhode Island Reds classified as pause and non-pause individuals.

Hatching Date	Pause	Non-Pause
Earlier than Population mean	1206	555
Later than Population mean	928	686
Totals	2134	1241

Coefficient of correlation . . . . +.2326 ± .0110

This positive coefficient of correlation is of sufficient magnitude to establish a definite relationship between early hatching and the appearance of winter pause. This being the case, the assumption must be made that inheritance is not the sole controlling force concerned in the manifestation of winter pause.

9. Correlation Between Date of First Egg and Length of Winter Pause.

The date on which a pullet lays her first egg is dependent upon many factors. Among the most important of these are hatching date and age at first egg. Environmental influences such as character of ration, amount of free range, and weather conditions may, to some extent, hasten or retard the date of first egg. Date of first egg is important economically if not biologically.

The relation between date of first egg and duration of winter pause has been determined by means of the coefficient of correlation on the same group of 2134 birds studied in section 7. The birds were again classified as to winter pause into class intervals of ten days. The class interval used for date of first egg was fifteen days. Constants calculated are as follows:

Number of birds	2134
Mean date of beginning to lay (Oct. 29) . .	5.88
Date of beginning to lay standard deviation . .	±2.13
Mean length of winter pause	32.26
Winter pause standard deviation	±21.92
Coefficient of correlation	—.3205 ± .0131
Regression of date of first egg on winter pause . .	—.031
Regression of winter pause on date of first egg . .	—3.297

The date on which the birds began to lay ranged from August 16 to March 29 making 15 class intervals. Its standard deviation may be expected to be of considerable magnitude in relation to the mean as is shown above.

A negative coefficient of correlation of .3205 ±.0131 between time of beginning to lay and pause duration stresses an important relation between the two. Early laying, on the average, tends to increase the duration of the pause.

10. Correlation Between Time of Beginning to Lay Earlier Than the Mean and the Presence of Winter Pause for Total Population.

Time of Beginning to Lay in the Fall	Pause	Non-Pause
Earlier than Population mean	1210	456
Later than Population mean	924	785
Totals	2134	1241
Coefficient of correlation	+.3854 ± .0099	

A definite and significant correlation exists between early laying and the presence of winter pause. This fact suggests the importance of breeding for a specific age at first egg, and hatching on some special date to meet conditions of environment.

(b) Inherited Characteristics Concerned With Fecundity In Relation to Winter Pause.

In the category of inherited fecundity traits that may be considered in their relation to winter pause, the following may be grouped: age at first egg, weight at first egg, winter rate or intensity, length of winter cycle, size of winter clutch, annual rate or intensity and annual persistency. A study of the relative degree of correlation between these inherited characteristics and duration of winter pause as well as its presence or absence furnishes constructive information in breeding for high egg yield. Such analyses bring out important relationships as well as pointing out possible cases of genetic linkage.

11. Correlation Between Age at First Egg and Length of Winter Pause.

Age at first egg marks sexual maturity in the pullet. Age at first egg is inherited in Mendelian fashion according to Hays (loc. cit.). The importance of early laying to high winter and annual egg yield has been stressed in our publications as well as in those of other workers. The significance of knowing if there is a correlation between age at first egg and duration of winter pause is therefore very evident, since both are inherited traits and both are concerned in winter and annual egg yield. A study was therefore made on the 2134 pause birds already considered in sections 7 and 9. Age at first egg class intervals of ten days are used and the same class interval used for length of winter pause. The following constants were calculated:

Number of birds	2134
Mean age at first egg	203.26
Age at first egg standard deviation	±26.28
Mean length of winter pause	32.26
Winter pause standard deviation	±21.92
Coefficient of correlation	—.2329 ± .0138
Regression of age at first egg on winter pause . .	—.279
Regression of winter pause on age at first egg . .	—.194

The above coefficient of correlation is almost identical with that between hatching date and winter pause duration given in section 7. The range in hatching date covers 49 days, while the range in age at first egg covers 180 days. The fact therefore becomes evident that a slight change in hatching date would cause a greater change in winter pause duration than would the same change in age at first egg, as brought out by their respective regression coefficients. Herein lies the reason for emphasizing hatching date as of greater significance in relation to winter pause than age at first egg when they exhibit identical coefficients of correlation to winter pause duration.

12. Correlation Between Age at First Egg Below the Mean and the Presence of Winter Pause for the Total Population.

Age at first egg	Pause	Non-Pause
Earlier than Population mean	1337	549
Later than Population mean	797	692
Totals	2134	1241

Coefficient of correlation . . . . . . $+.3578 \pm .0101$

Attention should be called to the fact that time of beginning to lay and age at first egg each show almost identical correlation coefficients to the presence of winter pause. The interpretation is that age at first egg is the chief determinant of time of beginning to lay when the hatching dates are constant from year to year.

13. Correlation Between Weight at First Egg and Length of Winter Pause.

Available for this study are the records of 2106 birds, classed as pause birds, on which the body weight on the day of laying their first egg was secured. Thus a very small number of the 2134 birds previously considered is omitted from this study. The class interval used for body weight was the half pound and the ten-day class interval was again used for winter pause. The following constants were determined:

Number of birds	2106
Mean weight at first egg	5.55
Weight at first egg standard deviation . . .	$\pm .72$
Mean length of winter pause	32.32
Winter pause standard deviation	± 22.01
Coefficient of correlation	$+.0161 \pm .0147$
Regression of weight on winter pause . . .	$+.0005$
Regression of winter pause on weight . . .	$+.4908$

A range in body weight from 3.25 to 8.25 lbs. occurs in the population studied. The magnitude of the standard deviation in weight indicates, however, that extremely small or extremely large birds are the exception, since the coefficient of variability for body weight is only about 13 per cent.

The coefficient of correlation between body weight and winter pause duration is mathematically insignificant. This furnishes rather concrete evidence that a pullet's body weight when she lays her first egg bears no relation to the length of her winter pause.

14. Correlation Between Body Weight at First Egg Lower Than the Mean and the Presence of Winter Pause for Entire Population.

Weight at First Egg	Pause	Non-Pause
Below Population Mean	1139	655
Above Population Mean	967	544
Totals	2106	1199

Coefficient of correlation . . . . —.0110 ± .0117

The complete independence between weight at first egg and the presence of winter pause is shown by the above correlation coefficient. Evidently body weight is not a factor in either the manifestation of winter pause or its duration.

15. Correlation Between Winter Rate and Length of Winter Pause.

The group of 2134 birds exhibiting winter pause is used in these calculations. Winter rate or intensity was calculated for each individual bird in the following manner:—

The total number of eggs from first egg to March first was divided by the number of days from first egg to March first, less all pauses of four or more days in duration from November first to March first. By this method of calculation the actual net rate of laying is arrived at if the assumption is correct that a cessation of laying for four or more days during winter actually constitutes a winter pause. A four-day cessation of laying may generally be assumed to necessitate the omission of one clutch of eggs for the average bird and such omissions suggest the manifestation of winter pause. The following constants were calculated:

Number of birds	2134
Mean winter rate	65.69
Winter rate standard deviation	±8.74
Mean length of winter pause	32.26
Winter pause standard deviation	±21.92
Coefficient of correlation	—.1023 ± .0144
Regression of rate on winter pause	—.041
Regression of winter pause on rate	—.257

The above mean winter rate expresses the net rate of laying of all birds exhibiting winter pause. This rate of laying is compared in section 16 with that of the total population and that of the non-pause group above. The standard deviation for rate is of moderate magnitude compared with the standard deviation of many other fecundity characteristics.

A small but significant negative correlation suggests a very moderate tendency for high-rate birds to pause for a shorter period than do low-rate birds. Such a relationship is important from the breeding standpoint in that it hints at some linkage relation between the dominant genes for high winter intensity and the recessive gene for non-pause.

16. Correlation Between Winter Rate Below the Mean and the Presence of Winter Pause for the Total Population.

Winter Rate	Pause	Non-Pause
Below Population Mean	1688	784
Above Population Mean	446	454
Totals	2134	1238

Coefficient of correlation . . . . $+.3734 \pm .0100$

Winter rate as used in all the calculations is the net rate of laying with all pauses of four or more days deducted. The above table shows the relation of net rate of laying to the presence of winter pause. This table displays a moderately intimate relation between low net rate and the presence of winter pause.

17. Correlation Between Size of Winter Clutch and Length of Winter Pause.

Size of clutch represents the number of eggs laid on successive days. In very extreme cases a pullet may lay as many as fifty eggs in succession previous to March first and the same bird may exhibit a few clutches of one. In order to arrive at a constant to represent the clutch size of an individual bird, it has been necessary to calculate mean clutch size during the winter. Such calculations have been made on all pause birds. The range in mean clutch size of individuals was found to be from 1 to 11.9. The class interval used was 1. Only one bird was omitted from this study because its class range fell between 15 and 15.9. Clutch size is really a measure of intensity of laying. Its relation to winter pause duration is of marked significance in breeding for fecundity.

Constants obtained in this correlation study are as follows:

Number of birds	2133
Mean winter clutch size	2.41
Winter clutch standard deviation	± 1.11
Mean length of winter pause	32.27
Winter pause standard deviation	± 21.92
Coefficient of correlation	$-.0674 \pm .0145$
Regression of winter clutch on winter pause . .	$-.003$
Regression of winter pause on winter clutch . .	-1.325

On the average, winter clutch size closely approaches 2.5 but the magnitude of its standard deviation indicates considerable variability in clutch size. A small negative correlation was discovered between clutch size and winter pause duration. While this correlation is significant as judged by its probable error, it is of such small magnitude as to indicate practical independence between the characteristics being considered.

18. Correlation Between Winter Clutch Size Below the Mean and the Presence of Winter Pause for Entire Population.

Winter Clutch	Pause	Non-Pause
Below Population Mean	1425	616
Above Population Mean	709	624
Totals	2134	1240

Coefficient of correlation . . . . . . +.3412 ± .0103

A significant positive correlation between small winter clutch and the presence of winter pause appears above. In general, there is a greater tendency for birds that lay in small clutches to pause than for birds laying in larger clutches. The rate of functioning of the reproductive system must therefore bear a relation to winter pause.

19. Correlation Between Annual Rate or Intensity and Length of Winter Pause.

Annual rate represents or approximates the intensity of each individual bird for the pullet laying year. Inasmuch as this constant has been discussed in Technical Bulletin No. 7 of this station, space will not be occupied here by further discussion. Since winter pause represents a period of non-production, there must of necessity exist a negative correlation between annual rate and length of winter pause unless pause birds lay at a higher net rate than non-pause birds. This last point is, in part, discussed in section 16 of this report, where the net winter rate of the total population in relation to the pause and non-pause groups is considered. The important positive relation between annual rate and annual egg record makes the correlation between annual rate and length of winter pause of importance. Included in this study are the 1348 birds exhibiting winter pause and having complete annual records. The following constants were determined:

Number of birds	1348
Mean annual rate	53.79
Annual rate standard deviation	±9.07
Mean length of winter pause	32.29
Winter pause standard deviation	±21.77
Coefficient of correlation	—.4091 ± .0153
Regression of annual rate on winter pause . .	—.170
Regression of winter pause on annual rate . .	—.982

The mean annual rate of laying is lower than the mean winter rate of laying, which is 65.69. This difference may be attributed largely to the fact that in calculating annual rate no account is taken of winter pause or of broody pauses. In the winter rate calculations, winter pause days are not included and very few birds become broody before the end of the winter season. The standard deviation in annual rate is relatively small and suggests uniformity in annual rate of laying.

The coefficient of correlation is negative and of such magnitude as to indicate a significant relation between rate and length of pause. In other words, low annual rate and long winter pause tend to move together. In breeding for high annual intensity, winter pause must certainly be reduced in duration.

20. Correlation Between Annual Rate or Intensity Below the Mean and the Presence of Winter Pause for the Total Population.

Annual Rate	Pause	Non-Pause
Below Population Mean	858	209
Above Population Mean	490	593
Totals	1348	802

Coefficient of correlation . . . . $+.6649 \pm .0081$

The substantial magnitude of the above coefficient of correlation points to a pronounced tendency for low annual rate to occur with winter pause. The table above also shows that 80 per cent of the low-rate birds are pause birds while only 45 per cent of the high-rate birds are in the pause group. The conclusion, therefore, seems justified that winter pause operates very significantly to lower the annual rate of laying.

21. Correlation Between Annual Persistency and Length of Winter Pause.

Annual persistency represents the number of days of laying from the first egg to a pause of thirty or more days after March first. If no thirty-day pause occurs between March first and the date 364 days after the first egg, the bird is given a persistency of 365 days on ordinary years and 366 days on leap years. A cessation of laying for a period of thirty days or more during summer is a rather dependable indication of the onset of complete molt, which always signifies the conclusion of the biological laying year.

Persistency as indicated by time of molting has long been recognized as affecting egg yield, and poultry investigators have recommended the use of late molting birds for breeding purposes. Hurst (1921) was the first to offer a definite hypothesis concerning its mode of inheritance. He believes high persistency is transmitted as a single factor recessive. If a rest period in winter enables the bird to lay later in the fall than does the bird without the rest period, then persistency must depend in part upon the previous physiological activity of the reproductive organs, or possibly there is linkage between winter pause and high persistency. The same group of 1348 birds used in the two previous sections is studied below. Persistency range lies between 67 and 366 days with class intervals of 15 days. Following are the constants:

Number of birds	1348
Mean annual persistency	309.03
Annual persistency standard deviation	±54.89
Mean length of winter pause	32.39
Winter pause standard deviation	±21.77
Coefficient of correlation	+.1017 ± .0182
Regression of persistency on winter pause	+.256
Regression of winter pause on persistency	+.040

Mean annual persistency closely approaches ten months, but the range of variability is rather wide as shown by its standard deviation. This variability is no doubt due in part to many environmental influences as well as to differences in the inherited capacities of the birds. Only about five per cent of the population fall below 200 days in persistency so that the range 200 to 366 is a close approximation of the actual range. A study of frequency distribution for persistency does not reveal a bimodal curve as might be expected for a population made up of genetically early and late molting birds. Such information suggests two possibilities, namely, that environmental influences completely obscure the genetic phenotypes, or else that high persistency is not inherited in simple Mendelian fashion. The mode of inheritance of persistency is out of the scope of this report.

A small but significant positive correlation coefficient exists between persistency and winter pause duration. Thus there is a very slight tendency for birds with long winter pause to lay later in the fall than do short pause birds. Relatively little significance should be attached to a constant of such small magnitude, however.

22. *Correlation Between Annual Persistency Greater Than the Mean and the Presence of Winter Pause for the Total Population.*

Annual Persistency	Pause	Non-Pause
Above Population Mean	855	423
Below Population Mean	493	378
Totals	1348	801

Coefficient of correlation . . . . +.2156 ± .0139

A moderate degree of correlation is shown between the presence of winter pause and high persistency. There is thus a slight tendency for pause birds to lay later in the fall than do non-pause birds. Possibly the functional ability of the reproductive organs is somewhat extended by a period of non-production in winter. The relation does not appear to be pronounced, however.

(c) *The Absolute Relationship of Winter Pause to Egg Production.*

The duration of winter pause may be considered a factor affecting the number of eggs laid before March first as well as for the entire year. Since winter fecundity alone depends upon the inheritance of seven pairs of Mendelian factors (Hays, 1924), it is desirable and necessary to know something of the relation of winter pause to winter and annual egg record. Although fecundity is very complex in its mode of inheritance, its manifestation depends in part upon environmental conditions as division (a) of this report shows. The correlation between size of winter clutch and winter egg yield is first considered, then the correlation between winter pause and winter egg record, and finally the correlation between winter pause and annual production is studied.

23. *Correlation Between Size of Winter Clutch and Winter Egg Yield.*

The relation of winter clutch size to winter pause has already been considered in sections 17 and 18. In this section the relation of winter clutch size and winter egg production are studied. Since size of winter clutch is so often used as a criterion for selection by poultrymen, knowledge of its relation to winter fecundity is important. Records are available on 3376 birds upon which the following constants were ascertained:

Number of birds	3376
Mean size of winter clutch	2.57
Winter clutch standard deviation	±1.23
Mean winter production	61.08
Winter production standard deviation . . .	±25.79
Coefficient of correlation	+.4725 ± .0090
Regression of winter clutch in production . .	+.023
Regression of production on winter clutch . .	+9.884

The fact will be observed that the mean winter production above is greater than the mean length of winter cycle given in section 6. The mean length of winter cycle is less than mean winter production because the end of the winter cycle is determined by a four-day pause before March first while winter egg record does not cease until February 28 or 29. Winter egg record is highly variable on account of the complexity of its inheritance.

The magnitude of the above correlation coefficient emphasizes an important tendency for clutch size and winter production to move together. As a criterion of winter fecundity large clutch size is very important.

24. *Correlation Between Length of Winter Pause and Winter Egg Record.*

Winter pause represents a definite period of non-production, but the tendency of winter pause and winter production to move in opposite directions can only be measured by means of the coefficient of correlation. The group of 2134 pause birds has been tabulated to give this relationship. The following are the constants obtained:

Number of birds	2134
Mean length of winter pause	32.26
Winter pause standard deviation	±21.92
Mean winter production	56.87
Winter production standard deviation	±23.51
Coefficient of correlation	—.2873 ± .0134
Regression of winter pause on production	—.268
Regression of production on winter pause	—.308

Mean winter production is lower in the above group of pause birds than for the total population given in section 23 because non-pause birds tend to have higher winter records than do pause birds. About the same degree of variation in winter records occurs in both cases.

A rather significant negative correlation coefficient shows that in general an increase in length of pause is associated with a decrease in number of winter eggs. A coefficient of much greater magnitude would appear if the time element were the only consideration. There is the possibility that pause birds tend to possess desirable fecundity traits that are lacking in non-pause birds.

25. Correlation Between Winter Production Below the Mean and Presence of Winter Pause for Total Population.

Winter Production	Pause	Non-Pause
Below Population Mean	1273	463
Above Population Mean	861	777
Totals	2134	1240

Coefficient of correlation . . . . +.4255 ± .0095

The above table illustrates a rather pronounced correlation between low winter egg production and the presence of winter pause. Winter pause has, therefore, proven to be a trait inimical to high winter egg record throughout the nine-year period of the experiment here reported.

26. Correlation Between Length of Winter Pause and Annual Production.

There are available for study 1348 pause birds with annual egg records. Tabulations have been made to discover how the length of winter pause affects annual egg production. Following are the constants:

Number of birds	1348
Mean length of winter pause	32.39
Winter pause standard deviation	±21.77
Mean annual production	172.51
Annual production standard deviation	±41.07
Coefficient of correlation	—.2107 ± .0176
Regression of winter pause on production	—.112
Regression of production on winter pause	—.398

The mean annual record of the pause birds throughout the period is about 173 eggs. The range of variation in annual egg yield is wide, as is shown by its standard deviation. Greater homogeneity in heritable factors concerned in fecundity should reduce such variability.

The magnitude of the coefficient of correlation is sufficient to indicate that, in general, an increase in length of winter pause is accompanied by a decrease in annual egg production. The time lost in winter pause is not compensated for by heavier production either before or after the pause in any class of pause birds.

27. *Correlation Between Annual Production Below the Mean and the Presence of Winter Pause for the Total Population.*

Annual Production	Pause	Non-Pause
Below Population Mean	715	301
Above Population Mean	633	501
Totals	1348	802

Coefficient of correlation . . . . +.3056 ± .0132

Low annual production is significantly correlated with the presence of winter pause as shown in the above table. Even though such a short period as a four-day pause is considered, this correlation coefficient is of appreciable magnitude. Winter pause must, therefore, be classed as inimical to highest annual egg yield, for the pause birds averaged but 173 eggs while the non-pause group averaged 189 eggs.

General Discussion and Summary.

The length of the winter laying cycle is unquestionably modified by a series of environmental influences. Some of these influences are within while others are beyond control of the poultry breeder. Winter pause is the complement of the winter laying cycle and is important in that it vitally affects total fecundity.

Two distinct classes of pullets appear in the flock studied, namely, pause and non-pause. A group of pause birds studied beside a group of non-pause birds, both groups hatched on the same date and both groups starting to lay at the same age, yet the first showing a distinct winter pause, places the difference in the groups as inherent. Such a study within the family gives definite ratios of pause and non-pause pullets as Hays (1924) points out.

The line of demarkation between genetically non-pause birds that exhibit winter pause due to environmental influences and birds carrying the dominant factor (M) for pause cannot be drawn. The present paper is devoted to a consideration of the non-heritable and some heritable factors that may or may not affect winter cycle and winter pause. Genetic factors concerned with the inheritance of winter cycle length and winter pause duration have not been dealt with.

The major teachings of this study may be summarized:

1. In general, early-hatched pullets have a longer laying cycle than late-hatched pullets of the same flock.

2. Date of first egg exhibits a rather intimate negative correlation to length of winter cycle.

3. Age at first egg shows an appreciable negative correlation to length of winter cycle.

4. The winter egg record is intimately positively correlated with length of winter cycle.

5. Annual egg production is significantly correlated with length of winter cycle though less intimately than is winter record.

6. A minor though significant degree of negative correlation appears between length of winter cycle and length of winter pause.

7. Hatching date bears a significant but not intimate negative correlation to length of winter pause in the pause population.

8. Early hatching is positively correlated with the presence of winter pause in the total population of pause and non-pause birds.

9. Time of beginning to lay is significantly negatively correlated with length of winter pause in the pause population.

10. Time of beginning to lay is appreciably positively correlated with early hatching in the total population.

11. Age at first egg shows the identical degree of negative correlation to length of winter pause that it shows to *length* of winter cycle.

12. Early sexual maturity is positively correlated with the presence of winter pause in the total population.

13. Weight at first egg is independent of length of winter pause.

14. Light weight at first egg is not correlated with the presence of winter pause in the total population.

15. The net winter rate of laying holds a very slight negative correlation to length of winter pause in the pause population.

16. Slow rate of winter laying is rather intimately positively correlated with the presence of winter pause in the total population.

17. The average size of winter clutch is but very slightly correlated with length of winter pause in the pause population.

18. Small size of winter clutch is moderately positively correlated with the presence of winter pause in the total population.

19. Annual intensity shows a considerable degree of negative correlation to length of winter pause.

20. A very intimate positive correlation exists between low annual intensity and the presence of winter pause.

21. Annual persistency is but slightly positively correlated with length of winter pause.

22. Birds that pause during winter show a tendency to lay later in the fall than non-pause birds.

23. The mean size of winter clutches is rather intimately positively correlated with winter fecundity. Clutch size is a very good measure of intensity.

24. Length of winter pause is negatively correlated with winter production.

25. Low winter production exhibits a considerable degree of correlation to the presence of winter pause in the total population.

26. Length of winter pause is negatively correlated with annual egg record in the pause population.

27. Annual production below the mean is substantially correlated with the presence of winter pause in the total population.

28. Although winter cycle and winter pause are complements of each other, they are practically independent in duration in the pause group.

29. Winter pause is definitely shown to be a characteristic detrimental to both winter and annual fecundity, and should therefore be eliminated from flocks bred for egg production.

References

Davenport, E. 1907. Principles of Breeding. p. 471. Boston, New York, etc.: Ginn & Co.

Goodale, H. D. 1918. Winter cycle of egg production in the Rhode Island Red breed of the domestic fowl. Jour. Agr. Res. XII.: 547-574.

Goodale, H. D. 1918. Internal factors influencing egg production in the Rhode Island Red breed of the domestic fowl. Amer. Nat. **52**:65-94, 209-232, and 301-321.

Goodale, H. D., and Ruby Sanborn. 1922. Changes in egg production in the station flock. Mass. Agr. Exp. Sta. Bull. 211.

Hays, F. A. 1924. Inbreeding the Rhode Island Red fowl with special reference to winter egg production. Amer. Nat. **58**:43-59.

Hays, F. A., Ruby Sanborn and L. L. James. 1924. Correlation studies on winter fecundity. Mass. Agr. Exp. Sta. Bull. 220.

Hays, F. A., and Ruby Sanborn. 1926. Broodiness in relation to fecundity in the domestic fowl. Mass. Agr. Exp. Sta. Tech. Bull. 7.

Hurst, C. C. 1925. Experiments in Genetics. Cambridge: Cambridge University Press.

Pearl, Raymond. 1912. The mode of inheritance of fecundity in the domestic fowl. Papers from Maine Biol. Lab. 37.

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ANNUAL PERSISTENCY IN RELATION TO WINTER AND ANNUAL EGG PRODUCTION

By F. A. HAYS and RUBY SANBORN

This bulletin is the third in a series dealing with the five inherited traits in relation to fecundity. Those already published show the relation of broodiness and of winter pause to egg production; while a later publication will consider intensity in relation to fecundity.

The records show that high persistency is a trait much to be desired from the standpoint of production, and that there is no reason why it may not be combined with other desirable traits in the same individual.

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AGRICULTURAL EXPERIMENT STATION

AMHERST, MASS.

ANNUAL PERSISTENCY IN RELATION TO WINTER AND ANNUAL EGG PRODUCTION

By F. A. HAYS and RUBY SANBORN

Annual persistency, as terminated by the onset of complete molt, has been emphasized for more than the past three decades as of marked significance in the selection of breeding females for egg production. The cessation of egg production in summer or fall is generally accompanied by a complete change of plumage and this period of non-production may continue for 30 to 120 days. The exceptional hen may lay a considerable number of eggs while molting, but such individuals are of infrequent occurrence.

Hurst (1925) classifies laying hens into complete and partial-molt classes and states that there is complete cessation of laying in the first class while the second class sheds its feathers gradually and continues to lay for 13 or 14 months after the first pullet egg. According to Hurst, complete early molt depends upon the inheritance of a dominant Mendelian gene.

Goodale and Sanborn (1922) note that cessation of production in the summer or fall at the end of the pullet laying year has a genetic foundation as indicated by the behavior of families in this respect. Data collected on the Massachusetts Agricultural Experiment Station flock of Rhode Island Reds show that the biological laying year may extend to 14 or 15 months as a maximum with 6 or 7 months as the minimum for normal birds. A study of all factors affecting the duration of the pullet laying year in the flock in question has not yet been completed.

A flock bred for egg production should theoretically consist of two general classes of birds with respect to persistency, namely, a high persistent class and a low persistent class. In reality these two classes do not stand out distinctly to form a bimodal curve when all the birds with annual records for the nine-year period are tabulated in persistency classes using 15-day class intervals. (See chart 1.) The probability exists, however, that environmental forces largely obscure these expected classes. A tabulation of the 2179 birds with annual persistency records does give a frequency distribution that is indistinctly bimodal and furnishes the basis for classification of those birds laying for a shorter period than 315 days as low in persistency and those laying for 315 days or longer as high in persistency. Such a classification is largely arbitrary, however, and is used in these studies only as a working basis until the true genetic point of division may be discovered.

Scope of This Report

This study was undertaken for a three-fold purpose, namely, to show (a) the relation between controllable environmental conditions and persistency, (b) the relation between inherited characteristics concerned with fecundity and persistency, and (c) the relation between persistency and fecundity. From the practical breeding standpoint these considerations are of great im-

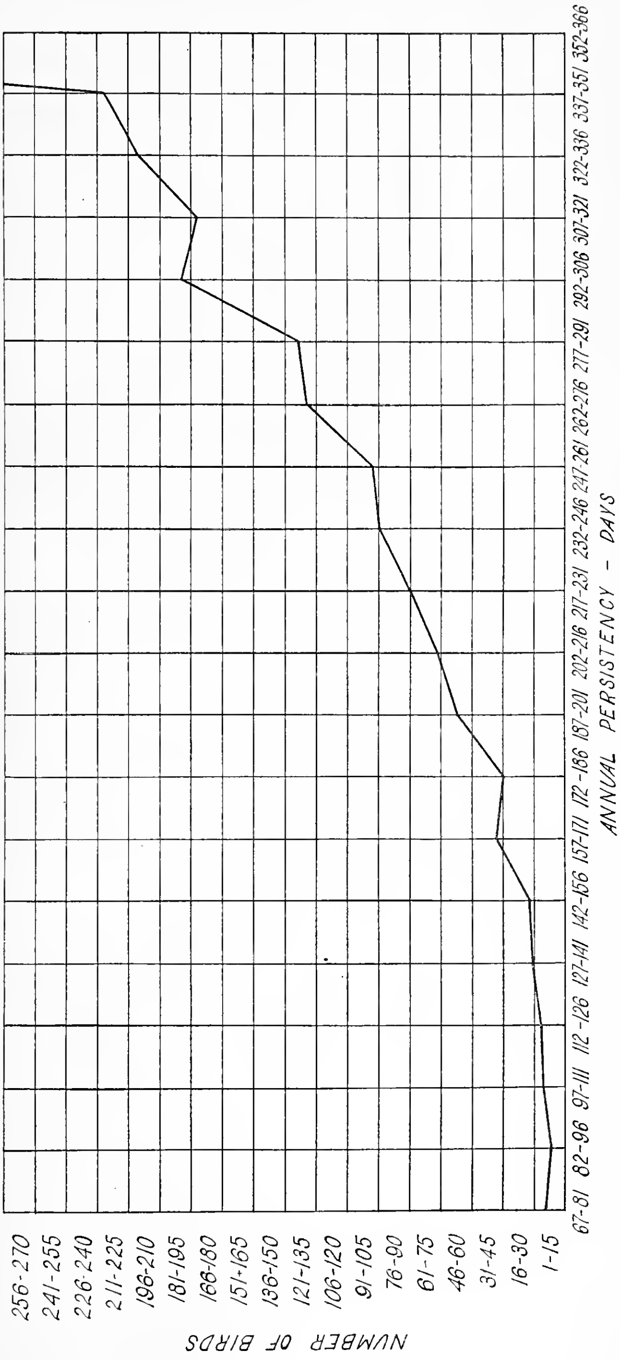

Chart 1. Frequency Distribution of Population with Regard to Persistency.

portance. A knowledge of the part played by environment as well as the part played by inheritance in limiting the manifestation of a desirable characteristic is well worth considering when breeding for egg production. Analytical studies on the complex nature of fecundity should further disclose valuable information that might otherwise be obscured.

Character of Birds Used

The birds used in this study are identical with those used in the two previous reports. Included are the records of all Rhode Island Red females hatched from 1916 to 1924 in the experimental flock upon which pullet-year trapnest records are available. The flock each year is made up of all the daughters of each hen whose progeny was retained. The major portion of the birds belong to the fecundity experiment. There are, however, a limited number of birds bred for non-broodiness, some for intense broodiness, some for hatchability, some for color, and a few inbreds that are included. Pullet-year records are used exclusively in this study.

The Coefficient of Correlation

The simple coefficient of correlation is subject to certain limitations in biological data yet it affords a basis upon which to select groups of breeders and also a basis for predicting future possibilities. The fact is self-evident that the simple coefficient of correlation is not an absolute measure of the degree of association between the variables being studied because each variable may be partially dependent upon other variables. For example, section 3 shows a negative correlation of $.6146 \pm .0090$ between age at first egg and annual persistency. It is a known fact that both the dependent variable, age at first egg, and the independent variable, annual persistency, are dependent upon hatching date and environmental conditions, and that persistency is also dependent upon weight at first egg and possibly upon length of winter pause. The true relation between age at first egg and annual persistency could only be arrived at by making the hatching date and environmental conditions constant, as well as by making weight at first egg and winter pause duration constant. Such procedure necessitates the use of partial coefficients of correlation which require the use of the simple coefficient in their calculation. Both the partial coefficient and the multiple coefficient will be employed in a concluding bulletin of the series. Simple correlations are of very significant practical value to the poultryman, however, in that they show him the relative importance of different environmental influences and inherited characteristics in relation to fecundity, and enable him to formulate his breeding program accordingly.

(A) Relation Between Environmental Conditions and Persistency

The only controllable environmental condition that will be considered in relation to persistency is hatching date. Extreme care has been exercised throughout the experiment to employ the same methods of feeding and brooding. Hatching dates have been kept constant each year, but there have been eight hatches each year at weekly intervals between March 25 and May 15. The range in hatching date thus amounts to 49 days. Hatching date, however, may be controlled at will by the poultryman.

1. *Correlation Between Hatching Date and Annual Persistency.*

The class interval for hatching date is seven days, and the class interval for annual persistency is 15 days with a range of from 67 to 366 days. The following constants were calculated on 2179 birds:

Number of birds	2179
Mean hatching date (April 18)	4.28
Hatching date standard deviation	±2.24
Mean annual persistency	300.47
Persistency standard deviation	±62.64
Coefficient of correlation	—.2208±.0137
Regression hatching date on persistency . .	—.008
Regression persistency on hatching date . .	—6.187

The above constants indicate that, on the average, the birds laid for 300 days before the onset of complete molt. This figure is somewhat lower than it would be if maximum persistency had not been placed at 366 days, because some of the birds laid for a greater time interval. The standard deviation in persistency amounts to almost 63 days and furnishes statistical evidence of very marked variability in persistency.

The coefficient of correlation between hatching date and annual persistency is negative and statistically significant. While this is not an intimate correlation, it does demonstrate a tendency for early-hatched birds to lay longer than late-hatched birds. The fact should be kept in mind, however, that the earliest hatch was taken off each year about March 25 and that this date should not be considered very early in this latitude.

2. *Correlation Between Hatching Date Earlier than the Mean and High Persistency.*

As previously stated, the birds have been divided into two classes with regard to persistency, namely, high and low. All birds are classed as *high* in persistency when they lay for 315 days or more before molting. Birds laying for a shorter period than 315 days are classed as *low*. By dividing the population of 2179 birds into these two classes for persistency, and by again classifying these as hatched earlier or later than the population mean, an absolute measure of the correlation between early hatching and high persistency is obtained. The results of this classification follow:

Hatching Date	High Persistency	Low Persistency
Earlier than population mean	720	458
Later than population mean	416	585
Totals	1136	1043

Coefficient of correlation . . . . +.3771±.0124

The division of the population into high and low persistency groups in the above table rests on a possible genetic foundation as already stated. The mean persistency of the entire 2179 birds was found to be about 300 days as section 1 shows. When the point of division between high and low persistency birds is taken between 314 and 315 days, there are 1136 individuals classifying as high and 1043 as low in persistency. The low persistency class ranges from 67 to 314 days while the high persistency class ranges from 315 to 366 days. The wide range for the low class enables them to bring the mean persistency of the population down to 300 days even though there are more high-persistency birds than low-persistency birds in the above classification.

A positive coefficient of correlation .3771±.0124 signifies that early hatching is associated with high persistency. Possibly early hatching better equips the pullet for a long laying year because she begins to lay earlier in the fall and is also able to finish her laying year under more favorable weather conditions than is her late-hatched sister. These data signifiy, therefore, that hatching before the middle of April tends to increase persistency for the pullet year.

(B) Relation Between Inherited Characteristics Concerned with Fecundity and Annual Persistency.

In the class of inherited characteristics concerned with fecundity the following will be considered in relation to annual persistency: Age at first egg, weight at first egg, winter rate, length of winter pause, and total days broody, all records being based on the pullet year.

3. *Correlation Between Age at First Egg and Annual Persistency.*

Both age at first egg and annual persistency have been found by Goodale and Sanborn (loc. cit.) and by the writers to be of appreciable significance in breeding for egg production. Both early maturity and high persistency are essential in the high producer and for this reason their relation to each other should be known. The identical group of birds studied in section 1 is used to determine the following constants:

Number of birds	2179
Mean age at first egg	208.56
Age standard deviation	±31.28
Mean annual persistency	300.47
Persistency standard deviation	±62.64
Coefficient of correlation	—.6146±.0090
Regression age on persistency	—.307
Regression persistency on age	—1.231

Mean age at first egg is about 209 days, which is a figure falling within the limits of genetic early maturity. Age at first egg is a characteristic that fluctuates widely, and in this particular population the extremes are 140 and 379 days, respectively. Class intervals of ten days for age have been used in these correlation studies.

The mean annual persistency of the population is about 300 days. The extremes are 67 and 366 days, respectively. The standard deviation for persistency is very large and indicates that a number of factors is concerned.

The negative coefficient of correlation is of such magnitude as to suggest an intimate relation between age at first egg and annual persistency. Those pullets that lay at an early age appear to be much more persistent layers than those maturing later. Herein lies a partial explanation of the significant relation between early maturing and high annual production. These studies point to age at first egg as a criterion of importance for predicting persistency.

4. *Correlation Between Age at First Egg Below the Mean and High Persistency.*

The population has again been divided into the two possible genetically different classes for persistency as in section 2. These classes have been tabulated against age below the mean and age above the mean as follows:

Age at First Egg	High Persistency	Low Persistency
Below population mean	860	387
Above population mean	276	656
Totals	1136	1043

Coefficient of correlation . . . . . . +.6816±.0077

A very intimate correlation is shown by the above coefficient between early sexual maturity and high persistency. This relationship is very significant to the breeder, disclosing possible genetic linkage between two desirable inherited traits that may later be cleared up on a factorial basis.

5. *Correlation Between Weight at First Egg and Annual Persistency.*

Body weight is a convenient standard to use for selection purposes. Weight in poultry is inherited on a multiple factor basis according to Punnett and Bailey (1914). If weight should prove a criterion of persistency, its value for culling purposes soon after pullets begin to lay is very evident. Weight records are available on 2125 of the birds being studied, and when correlated with persistency give the following constants:

Number of birds	2125
Mean weight at first egg	5.58
Weight standard deviation	±.75
Mean annual persistency	302.64
Persistency standard deviation	±58.00
Coefficient of correlation	—.3225±.0131
Regression weight on persistency	—.004
Regression persistency on weight	—25.002

This group of birds averaged about five and one-half pounds at first egg and the extremes are 3 and 9.5 pounds, respectively. Class intervals of .5 pound were used in making these studies. Weight shows a coefficient of variability of about 13 per cent.

The coefficient of correlation exhibits something of a tendency for light weight and high persistency to move together. Such a coefficient might have been anticipated from the fact that weight and age at first egg are positively correlated (Hays, Sanborn and James, 1924), and because hatching date and weight at first egg are negatively correlated (Hays, Sanborn, and James, loc. cit.). In view of these facts, it is doubtful if weight at first egg is a true criterion of persistency.

6. *Correlation Between Body Weight at First Egg Below the Mean and High Persistency.*

Weight at First Egg	High Persistency	Low Persistency
Below population mean	714	468
Above population mean	417	526
Totals	1131	994

Coefficient of correlation . . . . . . $+.3161 \pm .0132$

The above table presents the absolute correlation between weight at first egg below the population mean and high persistency. Those birds weighing less at first egg than the mean of the whole population may be considered small while the high persistency class includes only those individuals laying for 315 days or more before molting.

The coefficient of correlation is positive and of statistical significance. There is a tendency for the persistent class to weigh less at first egg than does the low persistency class. Although the correlation is significant, it is not pronounced and probably does not imply that factors for rapid growth are inimical to high persistency.

7. *Correlation Between Net Winter Rate and Annual Persistency.*

In order to discover if there is any association between the net rate of laying throughout the winter season and persistency of laying the following fall, a correlation table was made between winter rate and persistency, using the 2147 birds with records for both characteristics. The constants are as follows:

Number of birds	2147
Mean winter rate	67.41
Winter rate standard deviation	± 8.87
Mean annual persistency	302.98
Persistency standard deviation	± 59.03
Coefficient of correlation	$+.1835 \pm .0141$
Regression winter rate on persistency . . .	$+.028$
Regression persistency on winter rate . . .	$+1.222$

A slight but significant correlation is found to exist between winter rate of laying and persistency. This correlation indicates that, in general, there is some tendency for the more intense winter layers to persist in laying later in the fall than do less intense layers.

8. *Correlation Between Winter Rate Greater than the Mean and High Persistency.*

By classifying all birds with higher winter rates than the mean of the whole population as high for rate, and by classing as highly persistent all individuals laying for 315 days or more, the following table gives the correlation between high winter rate and the presence of possible genetically high persistency:

Winter Rate	High Persistency	Low Persistency
Above population mean	651	466
Below population mean	484	546
Totals	1135	1012

Coefficient of correlation . . . . . . $+.2236 \pm .0138$

The above tabulation presents a moderate degree of positive correlation between two inherited characteristics concerned in high fecundity. The very significant fact is brought to light that high winter rate and high persistency are partially complementary, and there is no evidence of antagonism between the two.

9. *Correlation Between Length of Winter Pause and Annual Persistency.*

The presence or absence of winter pause has been shown by Hays (1924) to depend upon genetic factors. The duration of the pause, however, may depend upon environment as well as inheritance. Most environmental forces affecting the duration of pause are probably beyond control of the breeder and may not properly be considered in this report. This section is devoted to a study of the correlation between length of pause and persistency as has already been done by Hays and Sanborn (1926b). In the population being studied there were 1348 birds with winter pause records which were divided into ten-day class intervals and the following constants arrived at:

Number of birds	1348
Mean length of winter pause	32.39
Pause standard deviation	± 21.77
Mean annual persistency	309.03
Persistency standard deviation	± 54.89
Coefficient of correlation	$+.1017 \pm .0182$
Regression persistency on pause	$+.256$
Regression pause on persistency	$+.040$

Winter pause duration is subject to extreme fluctuations. Its range extends from 4 to 130 days. The magnitude of its standard deviation indicates that its duration is affected by a considerable number of variables.

The above coefficient of correlation gives a statistically significant yet far from pronounced correlation between length of winter pause and annual persistency. There is but a very slight tendency for long-pause birds to persist longer than do short-pause birds.

10. *Correlation Between Annual Persistency Above the Mean and the Presence of Winter Pause.*

This section is devoted to a consideration of the presence of winter pause and annual persistency above the population mean of 303.20 days. Such a correlation will bring out any possible association between the heritable characteristic, winter pause, and high persistency which, in this instance, means persistency greater than the mean of the population studied. The classification follows:

Annual Persistency	Pause	Non-Pause
Above population mean	855	423
Below population mean	493	378
Totals	1348	801

Coefficient of correlation . . . . . . $+.2156 \pm .0139$

The correlation coefficient is significant though of only moderate magnitude. Possibly winter pause birds tend to lay for a slightly longer period than do non-pause birds because the former are more likely to be early-hatched (Hays and Sanborn 1926b), and early-hatched birds tend to be more persistent than late-hatched birds. The exact relation between pause and persistency can only be discovered through the partial coefficient of correlation and will be reported in a later publication.

11. *Correlation Between Total Days Broody and Annual Persistency.*

The heritable trait, broodiness, will next be considered in so far as its intensity as measured by total days broody is correlated with persistency. Only the pullets that exhibited broodiness during their first laying year are used to obtain the constants below:

Number of birds	1037
Mean total days broody	42.69
Broody standard deviation	±27.33
Mean annual persistency	294.05
Persistency standard deviation	±64.82
Coefficient of correlation	+.0532±.0209
Regression days broody on persistency	+.022
Regression persistency on days broody	+.126

Intensity of broodiness, as measured by the total days spent in broodiness during the pullet year is subject to wide fluctuations. Its standard deviation shows marked variability in the population. In view of this fact, it seems probable that intensity of broodiness depends on a number of variables.

The small and statistically insignificant coefficient of correlation indicates practical independence between degree of broodiness and annual persistency.

12. *Correlation Between Annual Persistency Above the Mean and the Presence of Broodiness.*

This section deals with the absolute relation between the presence of the inherited characteristic, broodiness, and persistency greater than the mean of the population studied. Herein lies a definite basis for selection which may or may not be useful in breeding for high persistency. The following results appear:

Annual Persistency	Broody	Non-broody
Above population mean	566	715
Below population mean	471	390
Totals	1037	1105

Coefficient of correlation . . . . —.2081±.0139

The above negative correlation coefficient is statistically significant though it does not reveal an intimate correlation. Eliminating the broody characteristic should in some measure increase annual persistency.

(C) The Relation Between Persistency and Fecundity

Since high annual persistency appears to be a desirable characteristic to develop from several standpoints, it is highly desirable that its relation to both winter and annual egg record be ascertained. Both relations may be considered first from the quantitative standpoint and then from the qualitative standpoint by use of long and short correlation tables, respectively.

13. *Correlation Between Winter Production and Annual Persistency.*

Winter production during the pullet year is represented by the number of eggs laid from first egg to the end of February. It has already been pointed out by many workers as a valuable criterion of annual production. Class intervals of ten have been used to make the correlation table for the 2151 birds with winter records. Constants computed follow:

Number of birds	2151
Mean winter production	62.49
Winter production standard deviation . . .	±25.44
Mean annual persistency	302.82
Persistency standard deviation	±59.32
Coefficient of correlation	+.4551±.0115
Regression production on persistency . . .	+.195
Regression persistency on production . . .	+1.061

The degree of correlation between winter production and annual persistency is positive and of appreciable magnitude. Selection for persistency based on winter records should be of considerable value. Such a condition might be anticipated in view of the high correlation between early maturity and winter production and between early maturity and persistency.

14. *Correlation Between Winter Production Greater Than the Mean and high Persistency.*

In the tabulation below the population is classified into four qualitative groups, namely, high winter producers, low winter producers, possible genetically highly persistent, and possible genetically low persistent. The correlation is then determined between production above the mean and high persistency.

Winter Production	High Persistency	Low Persistency
Above population mean	712	345
Below population mean	424	670
Totals	1136	1015

Coefficient of correlation . . . . +.5306±.0104

This coefficient of correlation demonstrates a positive relation between high winter egg record and high persistency. In other words, selection based on winter records greater than the average should increase the percentage of late-molting or persistent birds.

15. *Correlation Between Annual Production and Annual Persistency.*

Other conditions being equal, any increase in persistency should be accompanied by an increase in annual egg yield. These are purely quantitative relations and in this manner some information concerning the value of high persistency from the fecundity standpoint may be ascertained. The same population of 2179 individuals is tabulated, using ten-day classes for production, to obtain the following constants:

Number of birds	2179
Mean annual production	177.46
Production standard deviation	$\pm$44.73
Mean annual persistency	300.47
Persistency standard deviation	$\pm$62.64
Coefficient of correlation	$+.7082\pm.0072$
Regression production on persistency . . .	$+.506$
Regression persistency on production . . .	$+.992$

The above coefficient reveals an intimate correlation between annual egg yield and annual persistency or the length of the laying year. These data furnish definite evidence to commend the practice of emphasizing late molting in breeding for high fecundity. On the average, any increase in persistency within the limits of the pullet laying year is advantageous.

16. *Correlation Between Annual Production Above the Mean and High Persistency.*

By classifying all birds as high producers if they laid more eggs than the population mean of 177.46, and as high in persistency those birds that laid for not less than 315 days before molting, a definite relation between high production and high persistency may be established.

Annual Production	High Persistency	Low Persistency
Above population mean	872	280
Below population mean	264	763
Totals	1136	1043

Coefficient of correlation . . . . $+.8000\pm.0052$

The above coefficient of correlation establishes a very intimate relation between the presence of possible genetic high persistency and annual egg yield above the average of the total population. This fact points to high persistency as being closely associated with high annual fecundity. High persistency must, therefore, be classed as a trait of vital importance in breeding for fecundity and one that should be stressed greatly by the breeder. Should high persistency breed as a true recessive, it would be a comparatively simple matter to establish the characteristic in the laying flock.

Discussion and Summary.

Annual persistency is a characteristic bearing a vital relationship to fecundity. Its duration is affected by environmental influences and by inherited traits concerned in fecundity. No conclusive evidence is presented in this report to indicate that high persistency behaves as a simple recessive in inheritance as has been suggested by Hurst (loc. cit.). In this climate persistency may be increased to some extent by hatching before April 15, with such birds as are studied here. Early sexual maturity, non-broodiness and high winter rate probably show some linkage with high persistency. At any rate, there is no evidence of antagonism in attempting to combine these desirable traits in the same individual. Valuable information for selection purposes has been disclosed by these studies. Partial correlation coefficients will be used in a later publication to remove some complications.

The general relation of persistency to winter and annual production for the whole population studied is shown in the following table:

Character of Birds	Winter Production	Annual Production
Persistency above population mean	69.84	198.59
Persistency below population mean	51.57	145.67
Persistency of 315 days or more (Mean 347 days)	71.13	201.98
Persistency below 315 days (Mean 249 days)	52.83	150.75

Mean Persistency by Years

Year	Number of Birds	Average Persistency
1916	278	247.53
1917	347	280.74
1918	194	285.49
1920	125	325.29
1921	314	301.00
1922	379	329.67
1923	317	316.33
1924	225	320.47
Total and average	2179	300.19

The chief findings of this report may be summed up as follows:

1. Early hatching is moderately correlated with high annual persistency.

2. Age at first egg is very intimately negatively correlated with high persistency.

3. Weight at first egg shows significant negative correlation to persistency.

4. Winter rate of laying is moderately correlated with persistency. The two traits appear to be partially complementary.

5. Length of winter pause is but slightly positively correlated with persistency.

6. Total days broody is not significantly correlated with persistency.

7. The presence of broodiness shows a fair negative correlation to high persistency.

8. Winter production and persistency are rather significantly positively correlated.

9. Annual production is pronouncedly correlated with persistency.

10. Persistency behaves as a trait much to be desired from the production standpoint.

References

Goodale, H. D. and Ruby Sanborn. 1922. Changes in egg production in the station flock. Mass. Agr. Expt. Sta. Bull. 211.

Hays, F. A. 1924. Inbreeding the Rhode Island Red fowl with special reference to winter egg production. Amer. Nat. **58**:43-59.

Hays, F. A., Ruby Sanborn and L. L. James. 1924. Correlation studies on winter fecundity. Mass. Agr. Expt. Sta. Bull. 220.

Hays, F. A. and Ruby Sanborn. 1926a. Broodiness in relation to fecundity in the domestic fowl. Mass. Agr. Expt. Sta. Tech. Bull. 7.

Hays, F. A. and Ruby Sanborn. 1926b. Winter cycle and winter pause in relation to winter and annual egg production. Mass. Agr. Expt. Sta. Tech. Bull. 8.

Hurst, C. C. 1925. Experiments in genetics. p. 490. Cambridge: Cambridge University press.

Punnett, R. C. 1923. Heredity in poultry. New York, London, etc.: Macmillan and Co.

Punnett, R. C. and P. G. Bailey. 1914. On inheritance of weight in poultry. Jour. Genet. **4**:23-39.

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THE THERAPEUTIC EFFICIENCY OF AVIAN DIPHTHERIA, ROUP, AND BIRD POX VACCINES AND BACTERINS

By Norman J. Pyle

Avian diptheria, roup and bird pox cause serious loss to Massachusetts poultrymen by decreasing egg production during the season when eggs are bringing the highest prices. In this bulletin the Department of Veterinary Science and Animal Pathology reports results of their study of the problem. A filtrable virus was found to be the cause of all three types of the disease. None of the commercial vaccines produced immunity, neither did they effect a cure when the disease was present, although they caused a slight improvement in the general condition of the birds. Autogenous bacterins, when used in the early stages of the disease, caused an improvement in the general health of the birds, but were not of sufficient value to make their use economically profitable.

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THE THERAPEUTIC EFFICIENCY OF AVIAN DIPHTHERIA, ROUP, AND BIRD POX VACCINES AND BACTERINS

By NORMAN J. PYLE

Introduction

Avian diphtheria, roup, and bird pox have caused serious financial losses to the poultry industry of Massachusetts during the fall and winter months of past years. Diphtheritic roup has been the predominating form of the disease. It has not been attended with great mortality, but has become of grave economic importance because it has caused a decrease in production, occurring at a time of the year when poultry products bring maximum prices.

Two biological products, a powdered pox virus vaccine and an avian mixed infection bacterin, have been used extensively in an attempt to control the disease. The results obtained following the use of the preparations have been confusing. Some reports claim the vaccine to be 100 per cent efficient, while others claim it to be an absolute failure.

Many factors contribute towards the efficiency of the vaccine and bacterin. It is of primary importance to ascertain the nature of the causative micro-organism or virus and whether it is incorporated in either of the preparations. When this is accomplished, it is assured that either the vaccine or bacterin is the logical product to develop specific antibodies against the disease.

It is also necessary to determine whether avian diphtheria, roup, and bird pox are separate etiological entities or various manifestations of a common cause. On the answer to this problem depends the need for one common vaccine or bacterin or for separate ones for each entity.

Historical.

Moore (1), a pioneer American worker on avian diphtheria and roup, isolated a non-motile, pathogenic bacillus from lesions of the disease. He claimed that this organism was "apparently the etiological factor". He was unable, however, to determine its specificity for the affection. Harrison and Streit (2) demonstrated that *Bacillus pyocyaneus* would produce typical lesions of avian diphtheria and roup. These authors also found a second virulent bacterium associated with the diseases, which they called the roup bacillus or *B. cacosmos*. Hausser (3), Bordet and Fally (4), Beach, Lothe and Halpin (5), and Crofton (6) have all added specific organisms to the long list of causative factors.

Bird pox or contagious epithelioma has not been studied from the standpoint of its etiology to the extent that has avian diphtheria. Marx and Sticker (7) reported investigations wherein they found a filtrable virus to be the cause of bird pox. Schmid (8) and Sigwart (9) confirmed this work. V. Betegh (10), De Blieck and V. Heelsbergen (11), and others advanced the theory that all forms of the disease are caused by one and the same virus.

Several references in the early literature maintain that the various poxes, skin eruptions, and variola affecting animal life are all caused by a common virus, which adapts itself over a period of successive generations to a specific host. If this were true, vaccinia or cowpox would have an etiological relationship to bird pox.

Lowenthal, Kadowaki, and Kondo (12) were able to transmit vaccinia to the fowl through five successive generations, but the affections became less and less pronounced and finally died out. Fowls recovering from vaccinia were immune to vaccinia, and those recovering from bird pox were immune to bird pox. They were unable to produce a neutral or combination immunity and concluded that the causes of vaccinia and bird pox were very different.

Experimental Data on the Etiology of Avian Diphtheria Roup, and Bird Pox.

Bacteriological examinations of diphtheritic patches were made and many organisms were isolated, the majority of which were contaminating invaders. In order to avoid this the patches were aseptically removed and the bacteriological examination made directly from the underlying, denuded surface. The same technic was employed in the pox form of the disease; that is, bacteriological cultures were made from the pitted areas after removal of the pox scabs.

Pseudomonas aeruginosa (*Bacillus pyocyaneus*) was found associated with pox and diphtheritic lesions. This organism has been previously observed in diphtheritic roup by Harrison and Streit (2), Hausser (3), Jackley (13), Kaupp (14), and others. Various other pyogenic bacteria were isolated, namely, *Staphylococcus aureus, Gaffkya* (*Staphylococcus*) *tetragena,* and *Staphylococcus albus.* A *Pasteurella avicida*-like organism was isolated from infected birds suffering with avian diphtheria, also one similar to the roup bacillus or *Bacillus cacosmus* of Harrison and Streit (2).

These organisms are at least prominent secondary invaders, but their ability to cause diphtheritic roup is in doubt. *Pseudomonas aeruginosa,* when found in an infected flock, was readily isolated from the heart blood, liver, and spleen of those birds dead of the disease. The organism was injected into the wing veins of several healthy birds and death ensued in from fifty-six to eighty-four hours. The germ was recovered from the dead fowls, especially from exudates in the nasal passages, indicating that the organism was associated with roup. Other experiments with the organism, such as injection beneath the skin and application to scarified wounds of the comb, wattles, and membranes of the mouth, failed to produce any type of the disease.

Fresh pox scabs obtained from a Massachusetts infected flock were dried, passed through a coffee mill, and finally pulverized in a ball mill. One gram of this powdered virus was macerated for twelve hours and afterwards triturated in 100 cc. of physiological salt solution. It was then passed through a controlled Berkefeld filter of medium porosity. The filtrate was vigorously rubbed into the scarified comb and wattles of healthy birds and failed to reproduce the disease in forty-three days. These birds were susceptible to avian diphtheria and bird pox for they later succumbed to inoculation with the unfiltered virus. The experiment was repeated, using scab virus from two other States, and again using a filter of medium porosity. The results were the same. The experiments were controlled by the respective unfiltered scab viruses which produced typical pox lesions in the usual incubation period.

It is known that the filtrable virus of smallpox will not pass through a filter of fine porosity, but will pass through one of coarser porosity. Accordingly, Berkefeld filters No. V (coarse) were next used and the results recorded in the following table. The filtrate proved "sterile" upon cultural examination.

TABLE 1. Filterability of Pox Virus with a Coarse Berkefeld Filter.

Bird	December 17	December 23	December 29	January 4	January 12	January 28	January 30
No. 1 (healthy)	Comb and wattles scarified. Filtrate applied by vigorous rubbing.	No pox	Several well formed pox nodules.	Pox nodules markedly developed.	Lesions still persistent.	Condition same.	Destroyed.
No. 2 (slight cold)	Comb and wattles scarified. Filtrate applied by vigorous rubbing.	No pox	No pox	No pox	Few well defined "cankers" roof of mouth.	Condition same.	Destroyed.
No. 3 (healthy)	Comb and wattles scarified. Filtrate applied by vigorous rubbing.	No pox	No pox	Small pox nodules on comb and eyelids. 1st stage of roup in evidence	Pox nodules still present. Few "cankers" on membranes of pharynx.	Condition same.	Destroyed.
No. 4 (healthy)	Comb and wattles scarified. Filtrate applied by vigorous rubbing.	No pox	No pox	Several small pox nodules on comb. 1st stages of roup in evidence.	Pox and roup clearing up.	Condition same.	Destroyed.
Control No. 5 (healthy)	Comb and wattles scarified. Unfiltered virus applied by vigorous rubbing	Pox well developed.	Pronounced pox production.	Maximum pox development.	Pox nodules mature.	Condition same.	Destroyed.
Control No. 6 (healthy)	Comb and wattles scarified. Unfiltered virus applied by vigorous rubbing	Pox well developed.	Pronounced pox production.	Maximum pox production.	Pox nodules mature.	Condition same	Destroyed.

Interpretation

1. The filtered virus produced pox, roup, and avian diphtheria, indicating that one and the same virus is capable of causing all forms of the disease.
2. Bird No. 2 had a simple catarrh when inoculated. This evidently lowered the resistance of mucous membrance surfaces and avian diphtheria followed.
3. The incubation period of the filtered virus was from twelve to eighteen days, while in the case of the unfiltered virus it ranged from seven to nine days. The filtered virus also produced a less pronounced form of the infection than did the unfiltered virus. These latter two points confirm the work of Schmid (8) in 1909.

A bacteriological examination of the unfiltered powdered virus revealed several secondary invaders, such as *Pseudomonas aeruginosa* and various Staphylococci. These organisms undoubtedly assisted the unfiltered virus in causing a shorter period of incubation and a more pronounced form of the disease.

The Uniformity of the Virulence of Commercial Viruses.

Before studying the efficiency of the powdered pox virus vaccines, it was desirable to ascertain the strength of the viruses which make up these commercial products.

Four groups of birds were inoculated on October 5th with four different strains of powdered pox virus. The course of the disease subsequent to the inoculation is represented by the respective lines A, B, C, and D in the following graph. Virus A was obtained on October 1 from a natural infection in Massachusetts and viruses B, C, and D were of commercial origin.

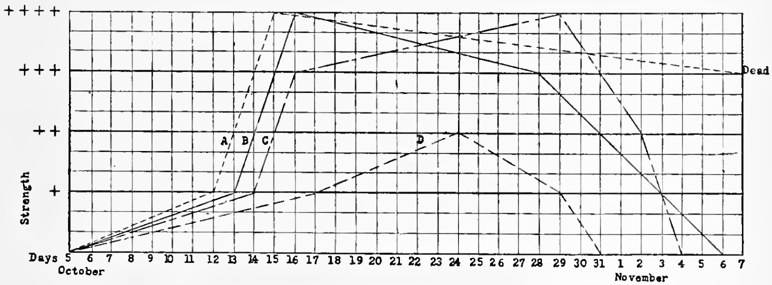

Chart I. Variance in Strength of Powdered Pox Viruses.

-|- Period of incubation.
-|--|- Appearance of a few or several well formed pox nodules.
-|--|--|- Appearance of many pox nodules of mature development.
-|--|--|--|- Maximum development of pox nodules.
Downward curves—Periods of recovery.

Virus A showed the greatest potency. The period of incubation was seven days, the disease reaching its maximum development three days later, and death following within twenty-three days with no appreciable evidence of recovery.

Virus B showed the greatest potency of the three commercial stock viruses. The period of incubation was eight days, maximum development four days later, and complete recovery in twenty-two days more.

Virus C presented an incubation period of nine days, maximum development fifteen days later, and complete recovery within an additional six days.

Virus D was very weak. The period of incubation was twelve days. There was practically no further development of pox and recovery soon took place.

Interpretation.

The degree of efficiency of the powdered pox virus vaccine depends upon the potency and antigenicity of the virus of which it is composed. The following conclusions are then evident:—

1. The viruses, being non-uniform in potency, would produce vaccines of varying efficiency.

2. A method of standardizing the virus and vaccine, which is lacking at the present time, would be essential to the efficiency of the vaccine.

3. An autogenous virus would produce a vaccine of greater value than one composed of a stock virus.

The Efficiency of Powdered Pox Virus Vaccines.

The powdered pox virus vaccine was first used by Manteufel (15) and by Hadley and Beach (16). The vaccine as commercially distributed to-day is a development of the original methods of these workers.

Scabs collected from pox nodules are the source of the virus. In order to produce large quantities of scabs it is necessary to maintain a flock of young cockerels, preferably white leghorns. The combs and wattles are scarified and the powdered scab virus after being "emulsified" in physiological salt solution is vigorously rubbed into the wounded areas. Typical pox scabs will develop and mature on susceptible birds in from seven to twelve days. The scabs are then collected, thoroughly dried, passed through a coffee mill, and finally pulverized in a ball mill. The product is stored away as the stock virus.

The vaccine is made by taking 1 gram of the powdered virus and thoroughly triturating it in 100 cc. of physiological salt solution. It is then attenuated at 55° C. for one hour in a water bath. Finally it is filtered through sterile cheesecloth into vaccine bottles, and after cooling is ready for use. The entire procedure should be handled in as sterile a manner as possible. The vaccine should be used within ten to fifteen days after it is manufactured because it deteriorates rapidly.

In the following experiments having to do with the efficiency of the powdered pox virus vaccines each bird was housed in a separate compartment. The final conclusions are based on a repetition of experiments and the average reaction of a group of birds. The vaccine used was manufactured as described by J. R. Beach (17), a brief description of which is given above.

Experiment 1.

Part A.

A freshly made vaccine, composed of virus B, was administered subcutaneously to a group of six healthy birds, 1 cc. being given to each bird beneath the skin of the breast under the right thigh. The group was divided into three lots of two birds each.

Lot 1. Fourteen days after vaccination both birds were inoculated on comb and wattles with virus B. Pox nodules developed eight days later and reached a maximum growth in an additional ten days.

Lot 2. Twenty-six days after vaccination both birds were inoculated on comb and wattles with virus B. A mild pox developed eight days later, but soon disappeared without further development.

Lot 3. Forty-two days after vaccination both birds were inoculated on comb and wattles with virus B. Pox was pronounced eight days later, one bird showing diphtheritic patches in mouth as well as pox.

Control: two non-vaccinated birds inoculated with virus B. Incubation period of eight days, maximum development four days later.

Part B.

Two injections of a virus B vaccine were given a second group of six birds in the same manner. The second injection was given six days after the first. The group was likewise divided into three lots of two birds each, and inoculated with virus B fifteen, thirty, and forty-two days respectively after the second injection.

Lot 1. Incubation period of ten days, pox becoming pronounced five days later.

Lot 2. Slight pox developed in eight days in only one bird, clearing up within the next seven days. Second bird showed no evidence of the disease.

Lot 3. Pox developed in ten days, persisting for three weeks in a mild form.

Control: two non-vaccinated, healthy birds inoculated with virus B. Pox developed in eight days, reaching a maximum development four days later.

Part C.

Three injections of a virus B vaccine were given a third group of six birds at intervals of six days. The group was again divided into three lots of two birds each, and inoculated with virus B sixteen, thirty-one, and forty-two days respectively after the third injection.

Lot 1. Pox developed in eleven days and persisted in mild form.

Lot 2. Pox developed in eight days and became pronounced in another week.

Lot 3. Pox developed in twelve days and persisted in mild form for three weeks.

Control: two non-vaccinated, healthy birds inoculated with virus B. Pox developed in eight days, reaching a maximum development three days later.

Result.

One, two, and three injections of the vaccine failed to produce an absolute protection against artificial infection with homologous virus B.

Experiment 2.

Part A.

This experiment was similar to Experiment 1, except that the vaccine was made of virus C and the check inoculations were made with virus B. The first group of six birds was given a 1 cc. injection of the vaccine, divided into three lots of two birds each, and inoculated with virus B seventeen, twenty-six, and forty days respectively after the vaccine injection.

Lot 1. Pox developed nine days later, grew worse, and death followed in one bird.

Lot 2. Pox developed within eight days, but in weak form, and cleared up in two weeks.

Lot 3. Pox developed within eight days in one bird and diphtheritic roup within ten days in the other.

Control: two non-vaccinated, healthy birds inoculated with virus B. Pox developed in nine days, reaching a maximum development four days later.

Part B.

A second group of six healthy birds was given two injections of a virus C vaccine of 1 cc. each at five day intervals. The group was divided into lots 1, 2, and 3 and inoculated with virus B sixteen, thirty, and forty days respectively after the second vaccine injection.

Lot 1. Pox developed in ten days and persisted in a mild form.

Lot 2. Pox developed in eight days in both birds and avian diphtheria in one bird of the lot.

Lot 3. Pox developed in eight days, becoming pronounced, and complicated with roup.

Control: two non-vaccinated, healthy birds inoculated with virus B. Pox developed in eight days and reached a maximum development three days later.

Part C.

A third group of six healthy birds was given three injections of a virus C vaccine of 1 cc. each at five day intervals. The group was divided into lots 1, 2, and 3 and inoculated with virus B fifteen, thirty, and forty-one days respectively after the third vaccine injection.

Lot 1. Pox developed in ten days and persisted in severe form for three weeks.

Lot 2. A slight pox developed in eight days, persisting in a mild form.

Lot 3. Pox developed in eight days, becoming severe and persisting as such.

Control: two non-vaccinated, healthy birds inoculated with virus B. Pox developed in eight days and reached a maximum development four days later.

Result.

One, two, and three injections of the vaccine failed to produce an absolute protection against artificial infection with heterologous virus B.

Other vaccine and virus combinations were used, such as a vaccine made of virus B, and its immunizing ability checked with virus C. The results were comparable to experiments 1 and 2.

Infection by Contact.

A healthy, young cockerel was added to each lot of the foregoing experiments after the disease developed in the supposedly immune birds. This addition of a strange bird to each lot of birds instigated fights, and minor wounds of the comb followed. This allowed a point of entrance for the virus which contaminated the food, water, and litter. Pox developed in about 50 per cent of those birds in contact with the diseased ones. The infection persisted in a mild form, never reaching the severity evidenced in those birds with which they were in contact.

Experiment 3.

An effort was made to determine the curative value of the vaccine. A group of twelve birds was inoculated with virus C. Pox nodules appeared in nine days and a moderate degree of development, which proved to be the maximum, followed in seven days. The group was then divided into two lots of six birds each and placed in separate pens. A virus C vaccine, in a 1 cc. dose was administered to each bird of one lot, the other lot being used as the control. No apparent decrease in number and severity of the pox nodules followed the injection of the vaccine. The injected lot, however, appeared brighter and more active, and loss of flesh was arrested after seven days following the injection. The non-injected lot steadily lost flesh for two weeks, but from then on gained in general appearance and physical conditions.

Results.

The use of the vaccine as a curative measure resulted in a slight improvement in the general condition of the treated birds, but did not cause any diminution in number or extent of the lesions.

One Attack of Bird Pox Confers an Immunity.

All birds recovering from the infection during the experiments were held over for future use. Approximately fifty days following complete recovery from both types of the disease, a group of such birds was inoculated wtih viruses B and C. Lesions of the disease failed to develop, indicating that one attack of the disease, whether of avian pox or diphtheritic type, confers an immunity of at least fifty days' duration. Four healthy birds which served as controls developed pox in eight days with virus B, and in nine days with virus C.

This actively acquired immunity is undoubtedly of greater duration than that demonstrated by the above experimental data. Evidence indicates that it lasts from two months to two years, depending upon the virulence of the infection among the birds which acquire this protection.

The Efficiency of Bacterins.

Several infected flocks were available during the fall and winter of the past year for treatment with bacterins. Autogenous bacterins were resorted to for the control of the outbreaks. Eleven different organisms, aside from the common *Subtilis* group, etc. contaminators, were isolated from diseased birds obtained from five outbreaks of bird pox and avian diphtheria. These organisms were not constantly present in all cases of the disease, and as has been previously stated, they are secondary invaders only. It appears, therefore, that an autogenous bacterin is indicated in preference to a stock bacterin. Also, such a preparation is limited to the control of secondary complications of the disease.

Commercial avian mixed infection bacterins were not used. Their bacterial content does not correspond to the specific bacteria isolated from lesions of birds affected with the disease as it exists in Massachusetts. McNutt (18) in referring to experimental data on the use of such a biologic concludes, "In every case the death loss among the treated equaled or exceeded the loss among the untreated. Usually the loss was greater among the treated."

Flock 1.

A pen, consisting of 112 birds affected with both pox and avian diphtheria, the latter predominating, was treated with an autogenous bacterin. Several of the worst cases of both forms of the disease were examined bacteriologically and the following organisms isolated: *Staphylococci aureus* and *albus*, *Gaffkya* (*Staphylococcus*) *tetrageua*, and an unknown, gram negative, short, rod-shaped organism of the colon group. The bacterin, composed of these organisms, was standardized so that one dose of 1 cc. contained 2,000,000,000 organisms.

An initial injection of 1 cc. was given to 80 birds of the pen, selected promiscuously, and 32 birds remained uninjected as controls. All birds were laying well prior to the outbreak of the infection. Both the injected and control groups averaged 43 per cent production at the time the first symptoms of the disease were noticed. Three days prior to the first injection the egg production of both groups dropped to 18 per cent. Fifty per cent of the total number of birds showed symptoms of one or more forms of the disease. There was no appreciable decrease in number or extent of lesions or increase in egg production of both groups during the next few days. The infection appeared to be arrested, however. Nine days following the first injection, a second one of the same dose was given. Three days afterward the injected group of layers improved in general condition and the egg production began to increase gradually. The condition and production of the control group remained at a standstill. These results were evident in the same proportions for the following two weeks, at the end of which time the last reading was taken. The injected group had reached 41 per cent egg production and the control group averaged 35 per cent. Lesions of the disease persisted, however, in all birds, but were somewhat less extensive in type.

In estimating the percentage of egg production care was taken to consider factors other than disease, which would tend to influence it.

Results.

The administration of the autogenous bacterin was followed by an improvement in the general condition and production of the injected group. No diminution in number or extent of the lesions was noted. Local treatment of the lesions would probably have served the purpose.

Flock 2.

An autogenous bacterin was administered to a second flock affected with avian diphtheria. The following organisms, which were used to make the bacterin, were isolated from typical cases of the affection: *Staphylococci aureus* and *albus, Gaffkya* (*Staphylococcus*) *tetragena,* a gram negative, short rod, bi-polar staining bacillus, and an organism of the *Escherichia* group, typical of *Escherichia schaefferi.*

A severe infection of a similar nature had existed in these same pens during the previous season. At the time of the injection a moderate degree of the infection was present in the birds of houses 1, 2, and 3. One injection of 1 cc. of the bacterin, having a concentration of 2,000,000,000 organisms per cc., was given each bird. Previous to the treatment the egg production had dropped to 40 per cent. From four to six weeks later when final readings were made the production had increased to 66 per cent. House 1 contained 2.8 per cent injected birds showing mild symptoms of the disease as opposed to 11 per cent of the non-injected birds or controls in the same condition. House 2 showed 12.3 per cent infection in injected birds and 30 per cent infection in the controls. House 3 showed 5.4 per cent infection in injected birds and 41.7 per cent infection in the controls. No attempt was made to treat the symptoms of the disease.

Results.

One injection of the autogenous bacterin arrested the course of the infection and brought about an increase in egg production.

Flock 3.

A third flock of 2,000 birds was injected, each bird receiving 1 cc. of an autogenous bacterin consisting of *Staphylococci aureus* and *albus,* and *Pseudomonas aeruginosa.* The bacterial concentration in this instance was but 500,000 organisms per cc. Complete data on the results of the treatment were not obtainable. An early report from the owner showed an improvement in egg production and but a few mild cases of the disease among the treated birds. It was questionable, however, whether the increase in production was due to recovery from the disease or from an existing neck moult. No data were available concerning the controls. No conclusion can be drawn from the use of the bacterin in this instance.

Flock 4.

A fourth flock of 300 cockerels was injected with an autogenous bacterin composed of *Staphylococcus aureus*, a *Pasteurella avicida*-like organism, and a bacillus similar to the roup bacillus or *B. cacosmus* of Harrison and Streit (2). The infection had practically run its course at the time of the treatment. Two injections were given, the first of 0.5 cc. containing 500,000 organisms, and a second six days later of 1 cc. containing 1,000,000 organisms. The disease entirely cleared up during the following three weeks. No difference was noted between the injected and control groups.

Summary.

1. Several organisms were isolated from the lesions of avian diphtheria, diphtheritic roup, and pox. They proved to be of no causative significance, but were prominent secondary invaders. A filtrable virus was found to be the common cause of all types of the disease.

2. Commercial stock powdered pox viruses varied markedly in ability to produce the disease. The need of a method of standardizing the virus and vaccine was indicated.

3. One, two, and three injections of the powdered pox virus vaccines failed to produce an absolute protection against artificial infection with homologous and heterologous viruses.

4. Infection by contact occurred in 50 per cent of all cases.

5. The powdered pox virus vaccine caused a slight improvement in the general condition of diseased birds when administered as a means of bringing about recovery from the infection.

6. One attack of either or both types of the disease conferred an immunity of at least fifty days' duration against both types.

7. Autogenous bacterins, when administered in the early stages of the disease, caused an improvement in the general health of the birds. As avian diphtheria and pox advance in severity the egg production of hens decreases. With the injections of these bacterins, data at hand indicate that the egg production is increased. While all these observations are interesting and point to a certain degree of therapeutic efficiency; the time consumed in the manufacture, standardization, and administration of these bacterins would work against their use as an economic practice.

Bibliography.

(1) Smith, Theobald, and Veranus A. Moore: Investigations concerning infectious diseases among poultry. U. S. Dept. Agric., Bur. Anim. Indus., Bull. 8, p. 56, 1895.

(2) Harrison, F. C., and H. Streit: Roup: an experimental study. Ontario Agric. College Bull. 132, 18-22, 1903.

(3) Hausser, Albert: Bacteriologische Untersuchungen über Geflügeldiphtherie. Centralbl. f. Bakteriol., Parasitenk. u. Infekt.—Krankh., 1908, 1 Abt. Orig., Bd. XLVIII, S 535.

(4) Bordet, J., et V. Fally: Le Microbe de la Diphtherie des Poules. Ann. de L'Inst. Pasteur, 1910, T. 24, p. 563.

(5) Beach, B. A., H. Lothe, and J. G. Halpin: An outbreak of roup and chicken-pox in which the high mortality was apparently caused by a secondary invader. Jour. Infect. Diseases, 1915, 3, XVII, 554-58.

(6) Crofton, W. M.: Diphtheria of fowls: Its cause, prevention, and cure. Jour. Path. and Bacteriol., 1924, 4, XXVII, 456-58.

(7) Marx, E., und A. Sticker: Untersuchungen über das Epithelioma contagiosum des Geflügels. Deut. med. Wochenschr., 1902, S 893. Cited in Kansas Agric. Exp. Sta. Tech. Bull. 4, p. 7, 1917.

(8) Schmid, G.: Untersuchungen über der Beziehungen zwischen Geflügeldiphtherie und Epithelioma contagiosum. Centralbl. f. Bakteriol., Parasitenk. u. Infekt.—Krankh., 1909, 1 Abt. Orig., Bd. LII, S 200.

(9) Sigwart, A.; Experimentelle Beiträge zur Frage der Identität von Geflügeldiphtherie und Guflügelpocken. Centralbl. f. Bakteriol., Parasitenk. u. Infekt.—Krankh., 1910, 1 Abt. Orig., Bd LVI, S 428.

(10) Betegh, L. von: Uber die Beziehungen zwischen Geflügeldiphtherie und Geflügelpocken. Centralbl. f. Bakteriol., Parasitenk. u. Infekt.—Krankh., 1912, 1 Abt. Orig., Bd., LXVII, S 43.

(11) de Blieck, L. und T. van Heelsbergen: Impfung gegen Diphtherie und Geflügelpocken bei Huhnern. Deut. Tierärztliche Wochenschr., 1923 Feb., 8, Bd. XXXI.

(12) Lowenthal, W., Y. Kadowaki und S. Kondo: Untersuchungen über das Verhältnis der Geflügelpocken zur Vakzine. Centralbl. f. Bakteriol., Parasitenk. u. Infekt.—Krankh., 1925., Feb. 18, 1 Abt. Orig., Bd. XCIV, S 185.

(13) Jackley, J. G.: A study of the etiology of roup in birds. Kansas Agric. Exp. Sta. Tech. Bull. 4, p. 12, 1917.

(14) Kaupp, B. F.: A chromogenic bacillus from a case of roup. Jour. Infect. Diseases, 1918, 568-571.

(15) Manteufel: Beiträge zur Kenntnis der Immunitätserscheinungen bei den sogennannten Geflügelpocken. Arb. a. d. k. Gsndhtsamte., 1909-10, Bd. XXXIII, S. 305. Cited in Jour. Amer. Assoc. Instructors and Investigators in Poult. Husb., 1920, 1, VII, p. 3.

(16) Hadley, F. B., and B. A. Beach: Controlling chicken-pox, sore-head, or contagious epithelioma by vaccination. Proc. Amer. Vet. Med. Assoc., 1913, p. 704. Cited in Jour. Amer. Assoc. Instructors and Investigators in Poult. Husb., 1920, 1, VII, p. 3.

(17) Beach, J. R.: The Treatment and prevention of chicken-pox (contagious epithelioma) of fowls. Jour. Amer. Assoc. Instructors and Investigators in Poult. Husb., 1920, 1, VII, p. 3.

(18) McNutt, S. H.: Vaccination of poultry. Jour. Amer. Vet. Med. Assoc., July 1926, 4, XXII, 472-77.

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